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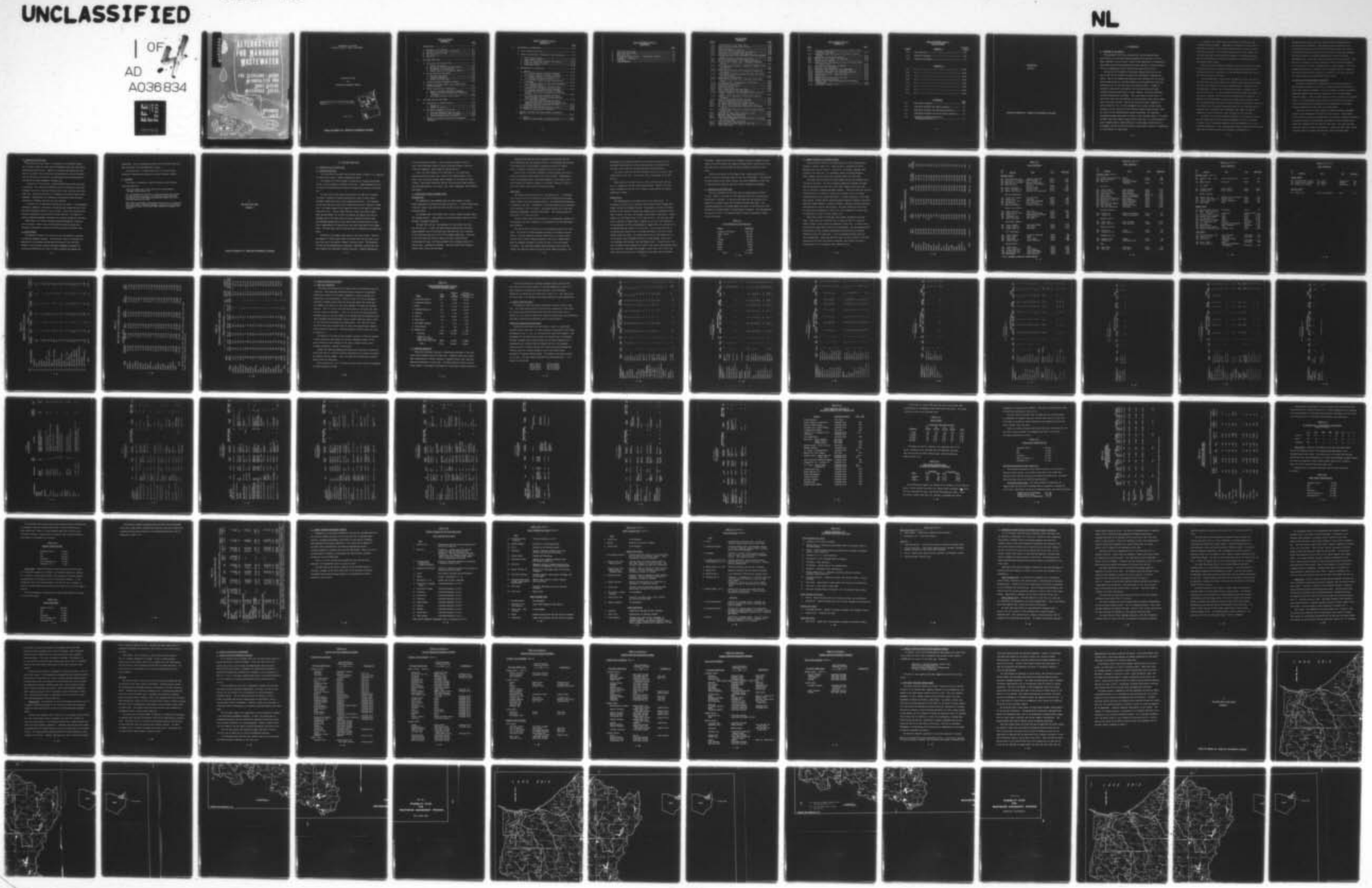

ALTERNATIVES FOR MANAGING WASTEWATER

FOR CLEVELAND — AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREAS.

APPENDICES I and II.

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DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS

FEASIBILITY STUDY

FOR

WASTEWATER MANAGEMENT PROGRAM

July, 1971

HAVENS AND EMERSON LTD. CONSULTING ENVIRONMENTAL ENGINEERS

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INTRODUCTION

APPENDIX I

HAVENS AND EMERSON LTD. CONSULTING ENVIRONMENTAL ENGINEERS

I - INTRODUCTION

A. STATEMENT OF THE PROBLEM

The population of the area centered about the Cleveland and Akron urban centers has a projected population growth from 2,420,000 in 1970 to about 4,160,000 in the year 2020. Growth of this magnitude in a metropolitan area creates many social-environmental-economic problems, of which pollution control and management of water resources are among the most vital.

The pattern of development of wastewater disposal facilities in this area to date has been typical of fringe areas surrounding a metropolitan center. Many of the suburban municipalities have extended their old village sewer systems beyond the corporate boundaries, serving additional areas and overloading both the existing sewers and treatment plants. A number of residential and business developments have been constructed with small "package" treatment plants which, in many instances, are poorly maintained and often hydraulically overloaded. Also, many homes have been built in areas where sewers are not available, so that individual units such as septic tanks, have been installed. Septic tank systems are often inadequate on small residential lots, or where impermeable soils cannot provide natural drainage, with the result that local drainage courses become polluted. When the quality of the receiving water becomes intolerable, the responsible governmental agency takes steps to install a local treatment plant. As the area develops, this cycle repeats itself, and the end result is a proliferation of small treatment plants, many of which are in some stage of construction or enlargement, and few of which can produce a high quality effluent as economically or consistently as a large plant.

In addition, the central cities of Cleveland and Akron have long standing pollution problems. Improvement of treatment facilities has not kept pace with growth, and the major treatment plants are only now being enlarged and improved. The Cleveland combined sewer system contains over 530 sewer overflows, which discharge raw sewage to the waterways during periods of storm flow, and similar discharges occur in Akron and many of the suburban sewer systems.

Finally the heavy industrial complexes of Akron and Cleveland discharge substantial quantities of partially treated wastes either directly to the Cuyahoga River and its tributaries, or into municipal systems which are not fully able to cope with the loads.

The increasing public concern about the quality of water, not only in Lake Erie but in the entire country, has created a new concern for wastewater collection and treatment by the public administrators. Consequently, the Ohio Department of Health has established water quality standards for all streams in this area. In some instances the present stream water quality is below these standards, and even further deterioration may be expected. In addition to the shortcomings in operation of septic tank systems and small local treatment plants, the need for higher standards of wastewater collection and treatment and the explosive potential growth of this study area make it essential that a coordinated water management plan replace the present ineffective system of providing "spot" solutions to local problems.

In order to solve the many pollution problems, it is necessary to prepare an overall plan for water resource management that will be regional in nature, free of restraints imposed by political boundaries or by local financing capabilities. Such a regional plan should be aimed toward consistent high levels of water collection and treatment, coordination and

centralization of the many pollution control efforts, and management of all phases of water resources. Such planning has been underway in the study area for some time; the Three Rivers Watershed District has carried out substantial studies during the last three years, and the Ohio Department of Natural Resources is currently preparing the Northeast Ohio Water Development Plan, of which the Interim Plan report has been completed. Also, the City of Cleveland is actively pursuing its Master Pollution Abatement Plan, and the City of Akron is progressing on a similar program. Thus, much background information is available, and a substantial amount of sound and consistent pollution control planning is available in this area, which has been heavily drawn upon in preparation of this study.

B. THE ROLE OF THE ARMY CORPS OF ENGINEERS

The Corps of Engineers has proposed that the planning capabilities and engineering experience of the Corps be directed toward the problems of total water resources management. The Corps intends to provide a wastewater management framework while working cooperatively with the Environmental Protection Agency. State and local agencies would be included in the planning effort. It is believed that current planning by State and local agencies can provide valuable basic groundwork for the formulation of long range programs designed to meet the needs of the environment.

The first step in the Corps' efforts to develop wastewater management programs is the preparation of feasibility level studies. These studies will be aimed at estimating the magnitude of the problem, evaluating alternative strategies available, and preliminary investigation of the strategies that appear most appropriate for the specific study area. Five areas have been selected to serve as "pilot" investigations. These pilot study areas include Cleveland, Detroit, Chicago, San Francisco, and the Merrimack Basin.

C. OBJECTIVES OF THIS STUDY

The objective of this study is to prepare a set of general concept (or "strategy") plans for water resource management within the Three Rivers - Metropolitan Cleveland area. Emphasis was placed on describing the study area at the present time, projecting the characteristics of the study area into the future to the year 2020, and identifying and evaluating possible alternative wastewater management strategies.

In Section II of this report, a detailed description of the study area is presented. This consists of population data, an inventory of wastewater treatment facilities, wastewater flows and waste loads, and land use in the study area. Existing water quality is compared to the present State Stream Standards. Proposed plans for extending or modifying existing wastewater collection or treatment facilities are also reviewed.

In Section III, the data were projected into the future. The demographic, industrial, commercial, residential, and agricultural characteristics of the area were projected by decades to the year 2020. Waste flows and loads were similarly projected to the year 2020 at decade intervals. The impact of current wastewater management strategies was evaluated through the year 2020.

Under Section IV, several alternate wastewater management strategies will be outlined. Water, land, and combination disposal concepts were developed in preliminary concept form and are presented for further study.

D. USE OF RESULTS

The feasibility study is the first of a two step procedure to develop a wastewater management program. The feasibility study will determine the magnitude of the wastewater problem from the present to the year 2020. Further, it will examine available wastewater management strategies for solving the problems and will focus on those strategies that appear most

appropriate. Also, the feasibility study will define areas where data gaps exist which will need additional research.

The second step is a survey scope which will develop needed additional information and evaluate the several concepts in depth.

E. AUTHORITY

This report is submitted in partial response to the following study authorization:

> "River and Harbor Act of 1966 (Public Law 89-789 approved 7 November 1966) Section 102.
>
> (a) The Secretary of the Army is hereby authorized and directed to cause surveys to be made at the following named localities and subject to all applicable provisions of Section 110 of the River and Harbor Act of 1950:
>
> Great Lakes, particularly Lake Ontario and Lake Erie, in connection with water supply, pollution abatement, navigation, flood control, hydroelectric power, and related water resources development and control."

II

THE STUDY AREA TODAY

APPENDIX I

HAVENS AND EMERSON LTD. CONSULTING ENVIRONMENTAL ENGINEERS

II - THE STUDY AREA TODAY

A. DESCRIPTION OF THE STUDY AREA

1. GENERAL DESCRIPTION

The Three Rivers Watershed District Basin shown on Figure II-1 is comprised of three river systems: Chagrin, Cuyahoga and Rocky.

The headwaters of these streams lie along the St. Lawrence-Mississippi divide, and flow generally northward to Lake Erie. Upper headwaters rise at elevations of 1250-1300 feet and drop to the Lake Erie elevation of 572 feet MSL.

The Three Rivers area extends from Eastlake (on Lake Erie) southeast to Chardon, southward to Ravenna and Hartville, north to Akron, thence westward to Medina and north to Bay Village and Lake Erie. Also included in the study area are several small stream basins directly tributary to Lake Erie. The named streams of this group are listed in the order of occurrence from east to west: Euclid, Green, Nine Mile Creeks, Shaw Brook, Dugway Creek and Doan Brook, all of which lie between the Chagrin River and the Cuyahoga; west of the Rocky River are Sperry, Cahoon and Porter Creeks. The combined drainage area of these minor creeks flowing directly to Lake Erie is approximately 133 square miles; the total study area is 1507 square miles. The main urban centers within the area are metropolitan Cleveland and Akron.

Cleveland is the largest urban center in the State of Ohio. The City was founded in 1796 by General Moses Cleaveland and since that time it has grown into one of the nation's largest industrial cities. The production of steel and the manufacturing of automobile components, machine tools and metal products are Cleveland's leading industries. Products manufactured

in the Cleveland area include: steel, automotive products, machine tools, fabricated metal products, paints, petroleum products, chemicals, electrical components, rubber goods and wearing apparel.

Akron, the fifth largest City in the State, is the second major urban area within the study area. Akron is the "Rubber Capital of the World"; four of the five largest rubber companies in the workd are based in Akron. Major Akron industries include: tires and other rubber products, road building machinery, auto bodies, salt, missle components, metal products and matches.

2. DESCRIPTION OF MAJOR WATERSHED BASINS

Cuyahoga River

The headwaters of the Cuyahoga River rise near Chardon in Geauga County approximately sixteen miles south of Lake Erie. It flows southwestward 50 miles to Akron, turns north and flows 42 miles to the river mouth at Cleveland harbor.

The drainage area is 813 square miles, lying in Geauga, Portage, Summit and Cuyahoga Counties. Small portions of Stark and Medina counties are also drained by Cuyahoga tributaries.

The upper 35 miles has a low gradient, for some reaches less than two feet per mile. At Kent, and again between Cuyahoga Falls and Akron, higher gradients (up to 56 feet per mile) drop the river to an elevation of 178 feet above Lake Erie at the Little Cuyahoga confluence. From Akron to the river mouth the stream is made up of short riffle sections alternating with long, slow flowing reaches with an average slope of 4.2 feet per mile. Meanders are numerous. The river reaches the navigation channel about 6 miles from the mouth.

Breakneck Creek and the Little Cuyahoga River watersheds are the major tributaries east and southeast of Akron. The highland area enclosed by the great bend of the Cuyahoga is drained principally by Tinkers Creek, a tributary entering the Cuyahoga River at river mile 17.

Water quality of the upper Cuyahoga is relatively good; the river is used as the principal water supply by the City of Akron. Downstream of Akron, the Cuyahoga becomes increasingly degraded, and the final 6 mile reach through the navigation channel in Cleveland's industrial valley is one of the nation's most severely polluted waterways.

Rocky River

The drainage area of Rocky River is 294 square miles. It discharges into Lake Erie at the City of Rocky River after flowing 48 miles through Medina, Summit, Lorain and Cuyahoga counties. The Cuyahoga River watershed is adjacent to the east. Geologically, the western portion of the watershed lies on generally flat till plains. The eastern portion lies on the more pronounced topography of the glaciated plateau. The average gradient of Rocky River is 7.1 feet per mile.

The West Branch rises south of Medina as the southernmost extremity of the watershed, and flows northward to the confluence with the North Branch east of Medina.

This branch and its feeder rise in the southeastern part of the river basin. The valleys for these headwater branches are in general wide and shallow. From the confluence the West Branch flows in a shallow valley northwest for 14 miles, turning northward to the City of Olmsted Falls, where the gradient increases to 18 feet per mile, to the East Branch confluence. The valley here becomes narrow and deep as the river cuts through the sandstone strata and into the softer underlying shales. The

East Branch rises near North Royalton in the east central part of the watershed, flows south for 8 miles, turns northwest near Hinckley and continues in this direction to Berea and West Branch confluence.

The lower 12 miles of the river continues to flow in a narrow, steep walled valley to the lake. In this last reach, the gradient is 6.5 feet per mile.

Water quality of the Rocky River is still relatively good, and the river is extensively used for recreational purposes. However, the water quality standards are not met in all respects, and potential for further degradation is great.

Chagrin River

The drainage area of the Chagrin River is 267 square miles. It discharges into Lake Erie at Eastlake after flowing 50 miles through Lake, Geauga, Portage and Cuyahoga Counties. Geologically, the area lies almost entirely on the glaciated plateau that comprises most of northeastern Ohio. Near its mouth, the river cuts through a narrow band of lake plain. Average gradient for the Chagrin River is 15.9 feet per mile. The main stem rises south of Chardon in Geauga County, adjacent on the west to the headwaters of the Cuyahoga, and flows southwestward to Chagrin Falls as a generally low to moderate gradient stream in a wide valley. The resistant bed rock of the plateau here creates reach of cascades and rapids as the river valley becomes narrow and steep. The Aurora Branch rises in the southern part of the watershed, flows northward, and enters a high gradient section near its confluence with the main stem near Chagrin Falls. The East Branch rises west of Chardon, flows westward for 4 miles, then enters a high gradient reach that extends as a northward flow through a narrow valley for 7 miles, and turns west for 10 miles to its confluence with the main stem in southern

Willoughby. Chagrin River then flows through a valley cut through the sand ridges of the post-glacial lake stages and deeper shales, entering the 2 mile wide lake plain, and then reaches the short navigation channel and river mouth.

Present water quality of the Chagrin River is good, and the river is used as a source of municipal supply by the City of Willoughby. The watershed has great potential for growth, however, and severe degradation of the river is expected unless extensive pollution control accompanies development.

3. POPULATION OF THE STUDY AREA

The total population of the study area was approximately 2,420,000 in 1970. Table II-1 presents the 1970 population data for the entire area broken down by counties. It can be readily seen that the majority of the population is centered about the Cleveland and Akron urban areas. The estimated population of Cleveland proper was 739,000 in 1970 while the total population of Cuyahoga County was approximately 1,630,000. The 1970 population of Akron was 273,000. The population data is based on preliminary results of the 1970 Census.

TABLE II-1

1970 POPULATION OF THE STUDY AREA

County	Population
Cuyahoga (Cleveland)	1,632,700
Summit (Akron)	466,300
Lake	108,700
Portage	101,600
Geauga	56,900
Medina	44,800
Lorain	8,100
Stark	1,900
TOTAL	2,421,000

4. CURRENT LAND USE AND INDUSTRIAL MAKEUP

Land use data in 1970 for the study area plus 14 other Northeast Ohio Counties is shown in Table II-2. Land use data is presented for the 20 Northeast Ohio Counties since it is desired to investigate treatment sites outside of the study area. The wastewater volumes and loads presented later, however, are only those that originate within the study area.

The entire area is within the outer suburban ring of the influence zones of Akron or Cleveland. The ring of bedroom communities continues to expand radially from these two urban hubs. Most heavy industry within the study area is centered in Cuyahoga and Summit Counties. Outside of these two counties, industrial areas are limited to several of the larger Cities or Villages including Ravenna, Kent, Medina and Burton. The major industries in the study area include: primary metals, fabricated metal products, machinery, electrical machinery, rubber products, automotive products, chemicals, building materials, food productions, textiles and printing. The major industrial firms within the study area are presented in Table II-3, and a breakdown of various types of industries by county is shown in Table II-4.

Rural areas consist of woodlands, dairy farms, greenhouses and truck farms. Rural land use in Northeast Ohio is shown in Table II-5, and the number of farms in each county are presented in Table II-6. In recent years, a trend toward larger farm sizes has been established. The Akron Metropolitan Park District and the Cleveland Metropolitan Park District own extensive properties within the study area; a ring of metropolitan parks encircles the Cleveland area. These park districts plan to control as much of the flood plains and river valley wall areas as possible, and to devote the area to recreational use, or to maintain other compatible uses.

TABLE II-2

LAND USE IN 20 NORTHEAST OHIO COUNTIES

County	Total Acres	Urban Acres	Non-Urban Acres	Farm Acres	Non-Urban Non-Farm	Land Area Sq.Miles
Ashland	272,600	4,800	267,800	207,300	60,500	426
Astabula	451,800	22,600	429,200	214,400	214,800	706
Carroll	253,500	900	252,600	165,500	87,100	396
Columbiana	342,400	9,400	333,000	178,900	154,100	535
Coshocton	360,400	3,000	357,400	224,900	132,500	563
Cuyahoga	291,800	250,200	41,600	16,900	24,700	456
Geauga	261,100	1,600	259,500	95,700	163,800	408
Harrison	263,000	500	262,500	130,100	132,400	411
Holmes	271,300	800	270,500	217,200	53,300	424
Jefferson	263,100	6,700	256,400	111,700	144,700	411
Lake	148,400	41,300	107,100	34,800	72,300	232
Lorain	316,800	70,600	246,200	184,600	61,600	495
Mahoning	271,500	29,400	242,100	105,400	136,700	424
Medina	272,000	9,900	262,100	160,500	101,600	425
Portage	323,900	23,400	300,500	142,800	157,700	506
Stark	371,800	20,900	350,900	188,000	162,900	581
Summit	266,200	75,400	190,800	41,900	148,900	416
Trumbull	404,500	17,800	386,700	166,200	220,500	632
Tuscarawas	365,400	6,100	359,300	201,500	157,800	571
Wayne	359,100	7,300	351,800	296,800	55,000	561
TOTAL	6,130,600	602,600	5,528,000	3,085,100	2,442,900	9,579

TABLE II-3

MAJOR INDUSTRIES

SIC* #	Industry	Type	City	Employees
CUYAHOGA COUNTY				
281	Allied Chemical Corp.	Inorganic Chemicals	Cleve.	89
336	Aluminum Co. of America	Alum. Castings	Cleve.	3,194
355	Anderson Div. of Ibec	Special Indus. Mach.	Cleve.	265
333	Brush Berylium	Smelting & Refining of Metals	Cleve.	315
345	Cleve. Cap Screw	Bolts and Nuts	Cleve.	657
372	Cleve. Pneumatic Co.	Aircraft Parts	Cleve.	1,980
354	Cleve. Twist Drill	Machine Tool Accessories	Cleve.	1,863
	Clevite Corporation -			
372	Gould Tech. Center	Aircraft Parts	Cleve.	92
371	Bearing Div.	Auto Parts	Cleve.	1,985
381	Brush Instr. Div.	Scientific Equipment	Cleve.	753
307	Dow Chemical	Misc. Plastics	Cleve.	1,205
281	DuPont de NeMours	Inorganic Chemicals	Cleve.	270
	Eaton, Yale & Towne -			
371	Eaton Axle Div.	Auto Parts	Cleve.	2,825
356	Fawick Airflex Div.	Power Transmissions	Cleve.	405
358	Heater Div.	Refrigeration Machinery	Cleve.	701
345	Tinnerman Prod.	Bolts and Nuts	Cleve.	869
371	Worm & Gear Div.	Auto Parts	Cleve.	306
	Ford Motor Company -			
332	Cleve. Foundry	Gray Iron Foundry	Cleve.	3,958
371	Engine Plant #1	Auto Parts	Cleve.	1,129
371	Engine Plant #2	Auto Parts	Cleve.	4,148
	G.E. Corporation -			
281	Chem. Products	Inorganic Chemicals	Cleve.	188
322	Cleve. Bulb	Glass	Cleve.	400
364	Lamp Plant	Elec. Lamps	Cleve.	1,800
363	Vacuum Cleaner	Vacuum Cleaners	Cleve.	858
	General Motors -			
193	Allison Div.	Tanks	Cleve.	2,441
371	Cleve. Chevy Div.	Auto Parts	Cleve.	7,819
346	Fisher Body Div.	Metal Stampings	Cleve.	3,501
364	Westinghouse Corp.	Lighting Fixtures	Cleve.	690
371	White Motor	Motor Vehicles	Cleve.	4,072

*** SIC = Standard Industrial Classification**

TABLE II-3 (Cont'd.)

MAJOR INDUSTRIES

SIC #	Industry	Type	City	Employees
CUYAHOGA COUNTY (Cont'd.)				
285	Glidden Durkee-SCM Corp.	Paints	Cleve.	360
289	Harshaw Chemical	Chemicals	Cleve.	340
363	Hupp, Inc.	Household Laundry Equipment	Cleve.	716
	J&L Steel -			
331	Cleve. Works	Blast Furnaces	Cleve.	4,305
349	Container Div.	Metal Barrels	Cleve.	111
345	Lamson & Sessions	Bolts and Nuts	Cleve.	1,022
362	Lear Sigler	Motors & Generators	Maple Hts.	1,176
362	Leece-Neville	Motors & Generators	Cleve.	1,450
371	Midland Ross-Frame Div.	Auto Parts	Cleve.	1,640
346	Modern Tool & Die Co.	Metal Stampings	Cleve.	1,000
353	Moto-Truc	Industrial Trucks	Cleve.	195
354	National Acme Company	Machine Tools	Cleve.	2,128
353	Otis Elevator	Industrial Trucks	Cleve.	1,015
371	Park Ohio Industries	Auto Parts	Cleve.	1,640
	Reliance Electric -			
362	Motors Div.	Motors & Generators	Cleve.	850
362	Control Div.	Industrial Controls	Cleve.	679
	Republic Steel -			
331	Cleve. Dist.	Blast Furnaces	Cleve.	7,087
345	Bolt & Nut Div.	Bolts and Nuts	Cleve.	1,117
	Sherwin-Williams -			
285	Paint Div.	Paints	Cleve.	558
209	Linseed Oil Div.	Linseed Oils	Cleve.	105
	Standard Oil Co. -			
295	Asphalt Plant	Asphalt	Cleve.	68
299	Refinery #2	Lubricating Oils	Cleve.	161
	TRW -			
371	Main Plant	Auto Parts	Cleve.	945
371	Valve Div.	Auto Parts	Cleve.	2,200

TABLE II-3 (Cont'd.)

MAJOR INDUSTRIES

SIC #	Industry	Type	City	Employees
CUYAHOGA COUNTY (Cont'd.)				
356	Towmotor, Ohio - Gear Div.	Power Transmissions	Cleve.	326
369	Union Carbide	Batteries	Cleve.	863
	U.S. Steel -			
331	Central Furnace	Blast Furnace	Cleve.	2,500
331	Cuyahoga Div.	Blast Furnace	Cleve.	1,000
	Warner & Swasey -			
354	Balas Colet Co.	Machine Tool Accessories	Cleve.	181
354	Cleve. Turn. Mach. Div.	Machine Tools	Cleve.	2,504
355	Textile Mach. Div.	Textile Machinery	Cleve.	310
191	Weatherhead	Guns	Cleve.	691
SUMMIT COUNTY				
271	Beacon Journal Pub. Co.	Publishing	Akron	637
202	Cons. Foods Corp. Milk Div. - Lawson's	Fluid Milk	Cuyahoga Falls	732
301	Firestone Tire & Rubber	Tires	Akron	8,284
301	General Tire & Rubber	Tires	Akron	4,139
301	B.F. Goodrich Co.	Tires	Akron	9,070
301	Goodyear Tire & Rubber	Tires	Akron	16,113
326	U.S. Stoneware, Inc.	Pottery	Tallmadge	535
353	G.M. Corp.	Construction Equipment	Hudson	1,790
346	Chrysler Corp.	Metal Stampings	Twinsburg	4,114
301	Mohawk Rubber Company	Tires	Akron	580
372	Goodyear Aerospace Corp.	Aircraft Parts	Akron	6,282
LAKE COUNTY				
225	Christiana Mills, Inc.	Knit Outerwear	Willoughby	572
289	Lubrizol Corp.	Chemicals	Wickliffe	1,023
306	Ohio Rubber	Fabricated Rubber Products	Willoughby	1,217
353	Cleve. Crane	Hoists	Wickliffe	780
382	Bailey Meter Co.	Mechanical Measuring Instruments	Wickliffe	1,882

TABLE II-3 (Cont'd.)

MAJOR INDUSTRIES

SIC #	Industry	Type	City	Employees
GEAUGA COUNTY				
306	Johnson Rubber Company	Fab. Rubber	Middlefield	683
306	Chardon Rubber Company	Fab. Rubber	Chardon	641
306	Geauga Ind. Company	Fab. Rubber	Middlefield	509
PORTAGE COUNTY				
362	Amatek, Inc.	Motors & Generators	Kent	755

TABLE II-4

INDUSTRIAL MAKEUP OF STUDY AREA

SIC #	Type of Industry	County						Six Counties Total
		Cuyahoga	Lake	Geauga	Summit	Portage	Medina	
19	Ordinance	2	-	-	-	1	-	3
20	Food	246	9	7	80	14	10	366
21	Tobacco	-	-	-	-	-	-	-
22	Textiles	31	2	-	3	2	-	38
23	Apparel	126	2	1	21	1	1	152
24	Lumber, Wood	45	8	12	15	9	5	94
25	Furniture, Fixtures	96	8	-	16	6	2	128
26	Paper	58	2	1	10	-	3	74
27	Printing, Publishing	395	14	7	71	8	11	506
28	Chemicals	211	17	7	27	2	8	272
29	Petroleum	42	2	1	6	-	3	54
30	Rubber, Plastics	80	11	11	76	35	4	217
31	Leather	11	-	-	1	-	-	12
32	Stone, Clay, Glass	114	15	6	36	15	13	199
33	Primary Metals	180	6	2	23	5	6	222
34	Fabricated Metals	644	44	9	118	10	22	847
35	Non-Elect. Machinery	827	105	14	191	45	20	1,202
36	Electrical Machinery	162	11	1	12	3	2	191
37	Transportation Equipment	69	14	-	15	4	2	122
38	Instruments	54	6	-	10	-	4	74
39	Misc. Manufacturing	121	5	2	26	5	5	164
	TOTAL	3,514	281	81	757	162	121	4,937

TABLE II-5

RURAL LAND USE IN 20 NORTHEAST OHIO COUNTIES

County	Cropland (acres) Harvested	Cropland (acres) Pastured	Cropland (acres) Misc.	Acres Woodland	Acres Pastured	Acres Other[a]
Ashland	101,500	13,700	19,300	34,100	21,700	17,100
Ashtabula	80,000	17,400	25,900	55,400	23,500	12,100
Carroll	54,700	7,600	11,800	33,200	39,200	18,900
Columbiana	78,100	9,600	16,300	25,200	30,000	19,700
Coshocton	63,100	13,900	20,500	43,900	67,000	16,500
Cuyahoga	6,200	1,000	3,200	3,200	400	3,000
Geauga	33,200	5,300	8,200	25,000	14,900	9,100
Harrison	28,100	7,100	5,600	23,300	51,800	14,100
Holmes	89,600	13,500	13,400	43,200	40,400	17,100
Jefferson	26,600	5,500	7,000	31,200	28,100	13,300
Lake	13,200	900	5,900	6,800	3,700	4,400
Lorain	104,000	11,300	20,500	23,600	11,100	14,000
Mahoning	46,300	5,800	10,600	15,400	17,300	10,000
Medina	79,900	10,200	18,500	21,900	16,200	13,800
Portage	58,500	9,300	16,600	29,800	15,500	13,000
Stark	102,800	10,100	15,300	19,600	22,600	17,500
Summit	17,000	3,700	6,200	6,000	4,100	4,900
Trumbull	57,300	19,900	20,100	36,400	22,000	10,500
Tuscarawas	64,300	14,900	16,600	38,200	45,800	21,700
Wayne	168,200	10,300	22,300	37,600	36,900	21,500
TOTAL	1,272,600	191,000	283,800	553,000	512,200	272,200

a. Includes house lots, barn lots, lanes, roads, ditches, ponds, and waste lands.

Source: Statistical Abstracts of Ohio 1969

TABLE II-6

FARMLANDS IN 20 NORTHEAST OHIO COUNTIES

County	Number of Farms	Number of Farms by Size: 0-49 Acres	50-99 Acres	100-179 Acres	180-259 Acres	260-999 Acres	1000-1999 Acres	Over 2000 Acres	Average Size of Farms (acres)	Estimated Average Farmland Value $/acre-1970
Ashland	1,471	269	401	419	198	182	2	-	140.9	$ 215.03
Ashtabula	1,737	367	499	520	202	147	2	-	123.4	241.70
Carroll	1,174	167	299	433	160	115	-	-	140.9	124.24
Columbiana	1,682	417	552	466	164	82	1	-	106.4	206.05
Coshocton	1,354	191	285	437	225	206	10	-	166.1	142.38
Cuyahoga	405	326	42	21	5	9	1	1	41.8	1,762.14
Geauga	804	169	280	234	69	48	3	1	119.0	325.93
Harrison	662	84	137	208	106	120	5	2	196.6	105.64
Holmes	1,779	292	521	692	154	118	1	1	122.1	193.25
Jefferson	797	169	187	267	91	80	3	-	140.1	139.96
Lake	523	320	113	56	14	19	1	-	66.6	778.04
Lorain	1,644	573	380	365	189	136	1	-	112.3	420.09
Mahoning	1,071	345	346	244	77	55	4	-	98.4	381.39
Medina	1,508	461	447	375	128	96	1	-	106.4	403.62
Portage	1,396	427	450	332	104	81	1	1	102.3	368.70
Stark	1,945	660	575	458	160	88	4	-	96.6	373.66
Summit	546	297	118	78	26	26	1	-	76.8	752.39
Trumbull	1,565	480	512	358	126	84	4	1	106.2	308.86
Tuscarawas	1,617	359	429	508	178	141	2	-	124.6	187.00
Wayne	2,398	553	679	718	234	209	4	1	123.8	326.57
TOTAL	26,078	6,926	7,252	7,189	2,716	2,042	51	8		

Source: Statistical Abstracts of Ohio 1969

B. CURRENT WASTEWATER MANAGEMENT

1. MUNICIPAL WASTEWATER

Municipal wastes constitute the largest source of wastewaters within the study area. These municipal wastewaters must be treated to a high degree before their release to the aquatic environment in order to prevent the degradation of our watercourses. Tables II-7 and II-8 list all municipal wastewater treatment plants within the study area larger than 20,000 gpd, and summarize the capacity of each plant together with degree of treatment provided. Table II-9 lists water filtration plants in the study area, which are also sources of wastewater. Table II-7 lists the ten largest municipal treatment plants in the area along with the effluent BOD and suspended solids loads discharged from these plants, based on annual operating reports, which in some cases may be exclusive of by-passed flows. This table also shows the total waste flows and loads from all other existing municipal treatment plants within the study area. Existing municipal treatment plants are shown on Figure II-2.

In addition to this data we have prepared estimates of flow and loadings of other wastewater constituents for 1970 and subsequent decades to 2020. These estimates include loadings of flow, BOD_5, suspended solids, total nitrogen, phosphorus, sulfates, and chlorides.

Sludges from existing water purification plants represent a significant pollutional load to a stream if suitable provisions are not made for treatment and disposal of such sludges. Table II-9 shows the existing water treatment plants within the study area.

Data in Tables II-7, II-8, II-9 and II-10 were derived from Ohio Department of Health records as of 1969.

TABLE II-7

PRESENT WASTEWATER FLOWS AND LOADS
AT EXISTING TREATMENT PLANTS

Plant	Flow (MGD)	Effluent BOD (lb/day)	Effluent Suspended Solids (lb/day)
1. Cleveland Easterly	117	18,539	20,491
2. Cleveland Southerly	80	11,342	15,345
3. Akron	71.2	17,200	43,941
4. Cleveland Westerly	34	40,549	29,490
5. Lakewood	17.1	1,140	2,567
6. Euclid	15.8	13,400	9,619
7. Rocky River	8.6	6,153	5,509
8. Willoughby-Eastlake	4	1,434	2,502
9. North Olmsted	3.6	387	506
10. Bedford City	3.1	853	750
Sub-Total	354.4	111,000	131,000
Totals from all other (112) Plants larger than 20,000 gpd	24.4	7,000	9,000
TOTAL	378.8	118,000	140,000

2. INDUSTRIAL WASTEWATER

Industrial wastewaters represent a significant percentage of the total waste volume produced within the study area. Industrial wastes may contain high concentrations of organic materials, suspended solids, toxic materials, chemical contaminants, or waste heat. Untreated industrial wastes may have severe effects on the aquatic environment or on municipal treatment processes.

The existing industrial wastewater treatment plants located within the study area are shown on Figure II-3 and are summarized in Table II-10. Major industries releasing their waste effluents to the Navigation Channel or its tributaries are summarized in Table II-11. This table shows the waste loads in the effluents from these industries to the Cuyahoga River.

3. RUNOFF, FLOWS AND LOADS

Precipitation runoff contributes significant pollution loads to Lake Erie. The runoff problem divides itself into two categories in this region: the average sustained flow from streams and drains which occurs in dry weather or as the result of normal low intensity precipitation; and intermittent high flows resulting from infrequent storms of high intensity.

Runoff from Intermittent Storm Events

Runoff from storm events has been shown to result in a significant pollution load to Lake Erie. In order to assess the magnitude of this input, hydrographs of the 1, 5, 10, 25, 50 and 100 year storms were computed. Unit hydrographs for the Rocky River at Berea, the Chagrin River at Willoughby, the Upper Cuyahoga River at Portage Path, and the Lower Cuyahoga River at Independence were available from the Buffalo District, Army Engineers. Design rainfalls for these years and this entire area were developed from Technical Paper 40, Rainfall Frequency Atlas of the United States Department of Commerce, Weather Bureau. The length of the design rainfall was 12 hours. The total depth of rainfall was distributed over 4 - 3 hr. periods as shown below:

First Period	15% of rainfall
Second Period	35% of rainfall
Third Period	35% of rainfall
Fourth Period	15% of rainfall

Table II-8

Municipal Wastewater Treatment Facilities
in the Cuyahoga Basin

					Wastewater Characteristics				Treatment		Hydraulic		
					Raw		Effluent		Efficiency		Loading		
Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Suspended Solids, mg/l	5-Day BOD mg/l	Suspended Solids, mg/l	5-Day BOD mg/l	S.S.%	BOD%	Current Flow, mgd	Design Flow, mgd	Ident. No.
Cuyahoga County													
Bedford	Wood Creek	.1	S & C	S	144	148	29	33	80	78	3.1	2.2	1
Bedford Heights	Bear Creek	3.8	S	S	272	189	107	80	61	53	1.1	.04	2
Cleveland Easterly	Lake Erie		S & C	S	151	119	21	19	86	84	117	123	3
Cleveland Southerly	Cuyahoga River	53	S & C	S	196	137	23	17	88	87	80	96	4
Cleveland Westerly	Lake Erie		S & C	P	187	186	104	143	44	23	34	36	5
Euclid	Lake Erie		S	I	252	182	73	102	71	44	15.8	18	6
Maple Heights	Swan Creek	0	S	S	332	425	148	165	55	61	.68	1.0	7
Solon - Central Area	Tinkers Creek	3.5	S	S	340	367	127	58	66.5	84	1.6	2.4	8
S.D. #1 - Parma Woodbury Hills	Big Creek Trib.	.1	S	S	384	293	41	34	89	88	.138	.12	9
S.D. #2 - Shar-Bon Seven Hills	Cuyahoga River Trib.	.1	S	S	375	287	35	36	91	87	.037	.05	10
S.D. #3 - Richmond Heights Scottish Highlands Subd.	Euclid Creek		S	S	367	116	33	4.4	91	96	.165	.16	11
S.D. #13 - Broadview Heights Bramblewood Subd.	Chippewa Creek	0	S	S	334	316	61	35	82	89	.014	.013	12
S.D. #13 - Brecksville	Cuyahoga River	49	S	S	260	155	25	19	90.4	88	1.07	1.0	13
S.D. #13 - Brecksville South. Estates	Cuyahoga River Trib.	0	S	S	347	246	57	37	83.5	85	.026	.03	14
S.D. #13 - Walton Hills	Tinkers Creek	4.1	S	S	409	109	67	6.6	83.5	94	.22	.25	15
Cloverleaf Hilltop, Inc.	Cuyahoga River		S	S		143		9		94	.007	.03	16
Pleasant Valley Shopping Center	West Creek	0	S	S								.035	17
Hillside Acres Subd. Seven Hills	Cuyahoga River Trib.	0	S	S								.1	18
Seneca Club Apts.	Chippewa Creek	0	S	S								.13	19
Geauga County													
Burton City Plant	E.Br. Cuyahoga	3	S	S							.07	.06	20
Broadwood Hills	W.Br. Cuyahoga	1.4	S	S	238	254	72	98	70	61.5		.0275	21

Table II-8 (Cont'd.)

Municipal Wastewater Treatment Facilities
in the Cuyahoga Basin

Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Wastewater Characteristics: Raw Suspended Solids, mg/l	Raw 5-Day BOD mg/l	Effluent Suspended Solids, mg/l	Effluent 5-Day BOD mg/l	Treatment Efficiency S.S.%	Treatment Efficiency BOD%	Hydraulic Loading Current Flow, mgd	Hydraulic Loading Design Flow, mgd	Ident. No.
Geauga County (Cont'd.)													
Middlefield	Cuyahoga River Trib.	.065	S	P							.326	.18	22
Middlefield Trailer Park	E.Br. Cuyahoga		S	S								.0275	23
Geauga Community Hospital	W.Br. Cuyahoga	0	S									.03	24
Nader's Trailer Park		0	S	P								.005	25
Jacques Mobile Home Park	Butternut Creek	0	S									.025	26
Plymouth Acres, Claridon S.D. #1		0	S	S	84	151	16	13	81	91		.012	27
Punderson State Park	Punderson Lake		S	S								.022	28
Medina County													
Granger Lake Apts.	East Yellow Creek	0	S	S								.04	29
Portage County													
Aurora Plant #2 - Geauga Lake	Pond Brook	1.17	S	S	90	254	23	23	74	91		.2	30
Aurora Plant #3 Four Seasons Subd.	Tinkers Creek	1.35	S	S	203	200	43	26	79	87	.176	.08	31
Kent	Cuyahoga River	5	S	S	187	226	13	15.5	92.8	93.3	2.3	4.0	32
Mantua	Cuyahoga River	19	S	S	168	113	25	19	85	83	.06	.3	33
Ravenna	Breakneck Creek	4.3	S	S	220	181	22	30	90	83.4	1.08	1.25	34
Aurora Acres S.D.	Aurora Pond		S	S	94	199	20	19	79	90.5	.05	.04	35
Brimfield S.D. #1	Plum Creek		S	S	218	173	12	5	94.5	97	.2	.2	36
Brimfield S.D. #2	Plum Creek		S	S								.006	37
Brimfield S.D. #3	Plum Creek		S	S	114	123	10	5.3	91.3	95.4	.034	.045	38
Field Local School Dist.	Mogadore Res.											.034	39
Franklin S.D. #1	Breakneck Creek	4.3	S	S	137	166	34	18	75.2	89.2	.076	.4	40
Franklin S.D. #3	Breakneck Creek	4.3	S	S	102	246	13	6	87	97.5	.026	.044	41
Gille Estates S.D.	Tinkers Creek Trib.	.15	S	S	189	201	13	6	93	97	.24	.44	42

Table II-8 (Cont'd.)

Municipal Wastewater Treatment Facilities
in the Cuyahoga Basin

Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Wastewater Characteristics: Raw Suspended Solids, mg/1	Raw 5-Day BOD mg/1	Effluent Suspended Solids, mg/1	Effluent 5-Day BOD mg/1	Treatment Efficiency S.S.%	Treatment Efficiency BOD%	Hydraulic Loading Current Flow, mgd	Hydraulic Loading Design Flow, mgd	Ident. No.
Portage County (Cont'd.)													
Kent Rhodes Apts.	Breakneck Creek	4.3	S	S								.03	43
Randolph Trailer Park	Congress Lake Outlet											.04	44
Ravenna S.D. #1	Breakneck Creek	4.3	S	S	94	152	8.5	7.6	90	95	.02	.02	45
Ravenna S.D. #4	Breakneck Creek	3			97	233	6	2	93.8	99	.004	.06	46
Rootstown S.D. #1	Reed Ditch	0	S	S	158	247	8	13	95	95	.05	.08	47
Shalersville S.D. #1	Cuyahoga River	12.3	S	S	98	258	12	6	88	98	.06	.16	48
Shalersville S.D. #2	Cuyahoga River Trib.	0	S	S	127	200	20	22.5	84.2	88.5	.13	.13	49
Streetsboro S.D. #2	Tinkers Creek Trib.	.15	S	S	157	244	10	8.4	93.6	96.7	.08	.06	50
Streetsboro S.D. #3	Tinkers Creek Trib.	.15	S	S								.07	51
Triple-B Trailer Park	Cuyahoga River Trib.	0										.025	52
West Pk. Mobile Home	Congress Lake Outlet												53
Summit County													
Akron	Cuyahoga River	25	S & C	S	277	139	74	29	73	79	71.2	87.5	54
Hudson	Brandywine Creek	0	S	S	177	265	22	39	87.5	85.3	.51	.55	55
Northfield	Cuyahoga River Trib.	0	S	S	220	294	26	37	88.2	87.4	.52	.4	56
Tallmadge	Camp Brook		S	S	158	367	4	8	97.5	97.8	.08	.15	57
Twinsburg	Tinkers Creek	3	S	S	213	208	24	24	89	88.5	.58	.6	58
S.D. #1 Roseland Est.	Tinkers Creek Trib.	0	S	S	192	182	12	12	94	93	.088	.1	59
S.D. #5 Hudson	Tinkers Creek	.7		S	177	171	6	5	97	97	.13	.2	60
S.D. #6 General Motors	Powers Creek	0	S	S	207	207	68	74	67	64	.66	.2	61
S.D. #7 Nagy Pk. Est.	Cuyahoga River Trib.	0		S	231	231	3	4	99	98		.03	62
S.D. #9 Macedonia Est.	Wallace Lateral	0	S	S	242	239	16	17	93	93		.03	63
S.D. #14 Renee Est.	Fish Creek	.1	S	S	237	238	5	4	98	98		.1	64
S.D. #15 Northfield-Macedonia	Brandywine Creek	1	S	S	208	211	10	12	95	94	1.02	1.0	65
S.D. #17 Conn. Colonys Allot.	Brandywine Creek	0	S	S	233	224	17	19	93	92	.03	.04	66

Table II-8 (Cont'd.)

Municipal Wastewater Treatment Facilities
in the Cuyahoga Basin

Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Wastewater Characteristics: Raw: Suspended Solids, mg/l	Raw: 5-Day BOD mg/l	Effluent: Suspended Solids, mg/l	Effluent: 5-Day BOD mg/l	Treatment Efficiency: S.S.%	Treatment Efficiency: BOD%	Hydraulic Loading: Current Flow, mgd	Hydraulic Loading: Design Flow, mgd	Ident. No.
Summit County (Cont'd.)													
Greenwood of Sagamore Hills	Cuyahoga River Trib.	88	S	S								.06	67
Hawthornden State Hospital	Cuyahoga River Trib.	.1	S	S								.3	68
Musical Arts Assoc. Blossom Music Center	Cuyahoga River Trib.	0										.09	69
Ohio Twenty-One Corp.	Furnace Run	0										.06	70
Revere Local School District	Cuyahoga River Trib.												71
Stow-Kent Assoc.	Fish Creek	.5	S	S								.03	72a
Click Store	Fish Creek	.5		S	138	133	6	4	96	97		.013	72b
K-Mart	Fish Creek	.5		S								.02	72c

Table II-8 (Cont'd.)

Municipal Wastewater Treatment Facilities
in the Rocky Basin

Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Wastewater Characteristics: Raw Suspended Solids, mg/l	Raw 5-Day BOD mg/l	Effluent Suspended Solids, mg/l	Effluent 5-Day BOD mg/l	Treatment Efficiency S.S.%	Treatment Efficiency BOD%	Hydraulic Loading Current Flow, mgd	Hydraulic Loading Design Flow, mgd	Ident. No.
Cuyahoga County													
Berea	E.Br. Rocky River	0	S & C	S	199	192	26	18	87	90.6	2.1	3.0	73
Brookpark	Abram Creek	.1	S	S	242	211	19	16.6	92	92	1.5	1.0	74
Lakewood	Rocky River	1	S	S	139	118	18	8	87	93	17.1	13.0	75
North Olmsted	Rocky River	.74	S	S	177	182	17	13	90	93	3.57	3.0	76
North Royalton - Area A	Baldwin Creek	0	S	S	183	174	12	3	93.5	98	.35	1.5	77
North Royalton - Area B	Baldwin Creek	0	S	S	193	202	6	3	97	98.5	.30	1.0	78
Strongsville - Area A	Rocky River Trib.	.02	S	S	248	100	21	3.5	91	96.5	.65	1.0	79
Strongsville - Area B	Rocky River Trib.	0	S	S	156	158	9	6	94	96	.21	.26	80
Strongsville - Area C	Rocky River Trib.		S	S	166	163	12	7	90.6	95.8	.115	.37	81
S.D. #6 Rocky River	Lake Erie			P	149	131	77	86	48	34	8.58	16.0	82
S.D. #8 Middleburgh Heights	Abram Creek	.1		T	214	152	128	100	40	34	.527	2.0	83
S.D. #8 Middleburgh Heights	Baldwin Creek	(Abandoned 1970)	S	S	424	324	61	40	86	86.5	.08	.05	
S.D. #12 Westlake													
Berkeley	Cahoon Creek	(To be aban-		S	215	157	33	9	85	94	.010	.037	
Canterbury	Cahoon Creek	doned 1971)		S	178	170	16	11	91	93.5	.063	.045	
S.D. #14 Brentwood Estates	Plum Creek			S	278	176	21	10	92.5	94	.17	.16	84
Lakewood Country Club	Porter Creek											.025	85
Olmsted Falls School Dist.	W.Br. Rocky River Trib.											.03	86
Westwood Meadows Apt.	Cahoon Creek			T								.017	87
Medina County													
Medina	W.Br. Rocky River Trib.	0	S	S	212	344	62	46	70.8	86.6	1.37	1.35	88
S.D. #5 Brunswick	W.Br. Rocky River	(Plan to abandon)	S	S	236	211	27	40	88.6	80.5		.16	89
S.D. #7 Colony Park	Healey Creek	0	S	S	182	179	7	6.7	96.2	96.3		.12	90
S.D. #8 Beverly Hills	Healey Creek	0										.26	91

Table II-8 (Cont'd.)

Municipal Wastewater Treatment Facilities in the Rocky Basin

Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Wastewater Characteristics: Raw: Suspended Solids, mg/l	Raw: 5-Day BOD mg/l	Effluent: Suspended Solids, mg/l	Effluent: 5-Day BOD mg/l	Treatment Efficiency: S.S.%	Treatment Efficiency: BOD%	Hydraulic Loading: Current Flow, mgd	Hydraulic Loading: Design Flow, mgd	Ident. No.
Medina County (Cont'd.)													
S.D. #9 Hinckley Lake	E.Br. Rocky River		S	S								.025	92
S.D. #11 Village Homes	W.Br. Rocky River		S	S								.012	93
S.D. #100 - Medina County	Rocky River Trib.	0	S	S	208	208	10	3.8	95.2	97.7	.80	2.0	94

Table II-8 (Cont'd.)

Municipal Wastewater Treatment Facilities
in the Chagrin Basin

Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Wastewater Characteristics: Raw Suspended Solids, mg/l	Raw 5-Day BOD mg/l	Effluent Suspended Solids, mg/l	Effluent 5-Day BOD mg/l	Treatment Efficiency S.S.%	Treatment Efficiency BOD%	Hydraulic Loading: Current Flow, mgd	Hydraulic Loading: Design Flow, mgd	Ident. No.
Cuyahoga County													
Chagrin Falls	Chagrin River	8	S	S	140	186	21	16	85	91	.5	.4	95
Pepper Pike - Creek Side	Chagrin River Trib.	0	S	S	248	100	21	3.7	91	96	.065	.04	96
Pepper Pike - Pepper Hills	Chagrin River Trib.	0	S	S	209	88	30	2.9	85	94	.037	.05	97
Hickory Hill - Mayfield Heights	Chagrin River Trib.	0		S	821	119	54	4.2	93	96	.016	.03	98
Solon - N. & NE. Area	Aurora Branch	4	S	S	117	141	16	24	86	83	.23	.78	99
Apple Hill Town House Corp. Moreland Hills	Chagrin River	0		S								.025	100
Country Club. Inc.	Country Club Lake		S	S								.05	101
Woodbran Corp.	Chagrin River Trib.	0		S	215	220	19	9	89	96		.22	102
Geauga County													
S.D. #2 Chester Twp. Willow Hills Est.	Caves Creek	.1	S	S	110	177	41	33	63	81		.012	103
S.D. #1 Bainbridge Twp. Pilgrim Village Subd.	Taylor Creek	.1	S	S	198	281	34	30	83	89		.025	104
Chagrin River S.D.													
Russel Park	Chagrin River	.1		S	93	107	17	6	82	95		.02	105
Wenhaven					70	116	12	16	83	86		.008	106
Opalacka	Chagrin River	.1		S	157	212	51	50	67.5	76		.08	107
McFarland Creek S.D.													
South Russel	McFarland Creek		S	S	188	228	19	14	90	93		.09	108
Ravenwood	McFarland Creek		S	S	165	251	20	25	86	90		.012	109
Tanglewood	McFarland Creek	0	S	S	105	120	30	9.5	71	92		.120	110
Knowles Indus. Park	McFarland Creek		S	S								.018	111
Newbury Local School	Chagrin River Trib.	0	S	S								.03	112
Silver Creek School Dist.	Silver Creek			S								.01	113
West Geauga Local School	Chagrin River Trib.	0										.06	114
Belle Vernon Acres	Chagrin River Trib.	0		S	41	43	22	4	46	91		.04	115
Wilder Mobile Home Park	E.Br. Chagrin		S	S								.03	116
Scarsdale Estates	Chagrin River		S	T	202	234	10.5	2.5	96	99		.024	117
Notre Dame Educ. Center	Chagrin River Trib.		S	S								.04	118

Table II-8 (Cont'd.)

Municipal Wastewater Treatment Facilities
in the Chagrin Basin

Municipality, Sewer District or Other Entity	Receiving Stream	Low Flow, mgd	Sewer System	Type of Plant	Wastewater Characteristics: Raw Suspended Solids, mg/1	Raw 5-Day BOD mg/1	Effluent Suspended Solids, mg/1	Effluent 5-Day BOD mg/1	Treatment Efficiency S.S.%	Treatment Efficiency BOD%	Hydraulic Loading: Current Flow, mgd	Design Flow, mgd	Ident. No.
Lake County													
Willoughby-Eastlake	Lake Erie		S	I	153	112	75	43	51	62	4.0	3.8	119
Willoughby Hills Dodd's Hill Subd.	Chagrin River	10.7	S	T								.024	120
Portage County													
Aurora (Plant #1)	Aurora Branch	1			New Plant - No data available.								121
Robins Trailer Park	Aurora Branch Trib.			P								.04	122

Table II-9

Water Treatment Plants
in the Three Rivers Basin

Water Treatment Plant	Receiving Stream	Plant Capacity mgd	Type of Plant	Sludge or Filter Backwash Treatment	Ident No.
Lake Erie					
Cleveland					
Baldwin	Doan Creek	190	Coagulation (Sulphate of Alumina), Filtration	No	123
Crown	Lake Erie	70	Coagulation (Alum-Lime), Filtration	No	124
Division	Lake Erie	160	Coagulation (Aluminum Sulphate), Filtration	No	125
Nottingham	Euclid Creek	175	Coagulation (Alum), Filtration	No	126
Cuyahoga River					
Akron	Cuyahoga River	75	Coagulation (Alum-Caustic Soda), Filtration	Yes	127
Kent	Plum Creek	3.5	Coagulation and Softening (Lime)	No	128
Cuyahoga Falls	Cuyahoga River	15	Coagulation (Lime), Iron and Manganese Removal (Aeration), Filtration	No	129
Streetsboro	(Wells) None	.90	Chemical Stabilization, Disinfection		130
Mantua	(Wells) None	.50	Disinfection		131
Hudson	(Wells) None	.432	Hard. Reduct., Chemical Coagulation Filtration, Chemical Stabilization, Mixing, Recarbonation, Sedimentation	Yes	132
Burton	(Wells)	.288	Chemical Stabilization, Disinfection		133
Middlefield		.72	Chemical Stabilization, Disinfection		134
Chagrin River					
Willoughby	Chagrin River	3	Coagulation (Alum), Filtration	No	135
Chagrin Falls	(Wells) None	.99	Chemical Stabilization, Disinfection		136
Aurora	(Wells) None	.432	Chemical Stabilization, Disinfection, Aeration		137
Rocky River					
Berea	E. Branch of Rocky River	3	Coagulation and Softening Lime and Alum, Filtration, Iron and Manganese Removal (Potassium Permanganate)	Yes	138
Medina	North Branch of Rocky River	4	Coagulation and Softening (Lime-Alum) Filtration	No	139

Table II-10

Inventory and Treatment Data
Industries and Other Systems
in the Cuyahoga Basin

Name of Industry	Type	Location	Receiving Stream	Critical Waste Constituents	Wastewater Characteristics - mg/l - Raw BOD	Raw SS	Effluent BOD	Effluent SS	Treatment Provided	Hydraulic Loading - mgd - Current Flow	Design Flow	Ident. No.
Cuyahoga County												
Air Reduction Co., Inc.; Airco Welding Products Div.; Arcross Plant	Welding Apparatus	Cuyahoga Heights	Cuyahoga River	Metals, Suspended Solids				168	Settling	.005	.017	1
Allied Chemical Corp.; General Chemical Division; National Works	Industrial Inorganic Chemicals	Garfield Heights	Mill Creek; Trib. of Cuyahoga River	Acids, Dissolved Solids, Suspended Solids				100	Neutralization	.036	.029	2
Alloys and Chemicals Corporation	Secondary Smelting and Refining	Cleveland	Cuyahoga River	Dissolved Solids, Suspended Solids, Color				555	Settling	.08	.08	3
Astoria Plating Corporation	Metal Plating	Parma	Trib. of Big Creek	Acids, Metals, Color				200	Neutralization, Settling Reduction		.36	4
Bedford Gear and Machine Products, Inc.	Mechanical Power Transmission Equipment	Walton Hills	Trib. of Tinkers Creek	Oil					None	.08		5
Burdett Oxygen Co. of Cleveland, Inc.	Industrial Gases	Cleveland	Cuyahoga River	Dissolved Solids, Suspended Solids					Settling			6
Cleveland Cap and Screw Company	Bolts, Nuts, Screws, Rivets, Washers	Warrensville Hts.	Cuyahoga River	Oil, Solids, Acids					Neutralization	.006		7
Cleveland Electric Illuminating	Power	Cleveland	Lake Erie	Solids, Temperature				500	Settling	7.2		8
Cleveland Metal Finishing Corp.	Electroplating, Polishing, Plating	Euclid	Trib. of Euclid Creek	Acid, Iron					None		.046	9
Cuyahoga Meat Company	Meat Packing	Cleveland	Big Creek	Oxygen Demand, Suspended Solids					Detention Lagoons		.01	10
DuPont de Nemours, E.I. Company	Industrial Inorganic Chemicals	Cleveland	Cuyahoga River	Acids, Zinc, Ammonia					Neutralization, Filtration	1.55		11
Elco Corporation	Lubricating Oils and Greases	Cleveland	Cuyahoga River	Oil, Hydrogen Sulfide					Separator	.066		12
Ford Motor Company; Cleveland Engine Plant #1 and #2	Motor Vehicle Parts	Brookpark	Trib. of Big Creek	Oils		45		3	Chemical Treatment, Settling, Separation	.342	.612	13
Goodrich-Gulf Chemicals, Inc.	Chemicals	Independence	Cuyahoga River	Organics, Suspended Solids			1.5 COD	12	Settling, Skimming	.144	.288	14
Harshaw Chemical Company	Chemicals	Cleveland	Cuyahoga River	Dissolved Solids, Suspended Solids					Settling, Filtration	1.5		15

Table II-10 (Cont'd.)

Inventory and Treatment Data
Industries and Other Systems
in the Cuyahoga Basin

Name of Industry	Type	Location	Receiving Stream	Critical Waste Constituents	Wastewater Characteristics - mg/l - Raw BOD	Raw SS	Effluent BOD	Effluent SS	Treatment Provided	Hydraulic Loading Current Flow - mgd	Design Flow	Ident. No.
Cuyahoga County (Cont'd.)												
Hydraulic Press Brick Corporation	Press Bricks	Independence	Hemlock Creek	Acid, Suspended Solids				6000	Neutralization, Settling	.325		16
Jones & Laughlin Steel Corporation												
Acid Iron	Steel	Cleveland	Cuyahoga River	Acid, Iron					Hauled Away; Controlled Release			17
Mill Scale	Steel	Cleveland	Cuyahoga River	Mill Scale, Iron				80	Chemical Treatment, Settling	64		18
Blast Furnace	Steel	Cleveland	Cuyahoga River	Iron, Solids, Toxic Materials				40	Settling	7.1		19
Master Anodizers & Platers, Inc., Bedford Architectural Spec.	Metal Finish	Walton Hills	Trib. of Tinkers Creek	Chrome, Acids, Al., S.S.				38	Chrome Reduction, Settling	.2		20
Modern Tool and Die Company	Metal Stampings	Parma	Big Creek	Oils, Suspended Solids			COD 331	152	None			21
Picker X-Ray Corp.; Waite Mfg. Div. Inc.	X-Ray Equipment	Highland Hts.	Trib. of Euclid Creek	Radioactivity					Secondary, Sand Filters	.02	.038	22
Republic Steel Corporation												
Bolt and Nut Division, Acid Iron	Steel	Cleveland	Cuyahoga River	Acid, Iron				400	Controlled Discharge	1.44		23
Bolt and Nut Division, Mill Scale	Steel	Cleveland	Cuyahoga River	Mill Scale, Iron				110	Scale Pits	1.23		24
Cleveland District, Blast Furnace	Steel	Cleveland	Cuyahoga River	Iron, Solids, Toxic Materials				300	Chemical Treatment, Settling	65	14.4	25
Cleveland District, Acid Iron	Steel	Cleveland	Cuyahoga River	Acid, Iron				50	Controlled Discharge	.72		26
Cleveland District, Plants #1 and #2	Steel	Cleveland	Cuyahoga River	Phenols, Ammonia				200	Closed Quenching System	40.4		27
Cleveland District, Mill Scale	Steel	Cleveland	Cuyahoga River	Mill Scale, Iron				170	Scale Pits, Oil Removal	57.84		28
Republic Steel Corp. Research Center	Research	Independence	Trib. of Cuyahoga River	Chemicals					Chemical Treatment, Clarification			29
River Smelting and Refining Company	Secondary Smelting and Refining	Cleveland	Cuyahoga River	Suspended Solids, Heavy Metals					Settling	2.03		30
Standard Oil Co. #2 Refinery	Lubricating Oils and Grease	Cleveland	Kingsbury Run	Oils				13	Oil Separation	.445		31
Standard Oil Co. Trunk Pipeline	Pipeline	Cleveland	Cuyahoga River	Chlorides, Dissolved Solids					None			32
TRW, Inc.; Jet and Ordinance Division	Aircraft Engines and Engine Parts	Euclid	Sandy Creek to Lake Erie	Acids, Alkalies, Cyanides, Chromium and Other Heavy Metals				90	Settling, Chrome and Cyanide Treatment	4.245		33
Tecumseh Corrugated Box Co.; Jaite Mill Division	Paper Mill	Brecksville	Cuyahoga River	Oxygen Demand, Suspended Solids	520		220	240	Aerated Lagoon, Settling	.10	Avg. - .09 Max. - .15	34

Table II-10 (Cont'd.)

Inventory and Treatment Data
Industries and Other Systems
in the Cuyahoga Basin

Name of Industry	Type	Location	Receiving Stream	Critical Waste Constituents	Wastewater Characteristics - mg/l - Raw BOD	Raw SS	Effluent BOD	Effluent SS	• Treatment Provided	Hydraulic Loading - mgd - Current Flow	Design Flow	Ident. No. -
Cuyahoga County (Cont'd.)												
United States Steel Corporation Central Furnaces	Steel	Cleveland	Cuyahoga River	Suspended Solids, Iron		2500		120	Thickening	6.52		35
All Outfalls	Steel	Cleveland	Cuyahoga River	Suspended Solids, Iron				50		40.57		36
Cuyahoga Works, Acid Iron	Steel	Cuyahoga Hts.	Cuyahoga River	Acids, Iron, Suspended Solids					Controlled Discharge, Hauled Away			37
Cuyahoga Works, Mill Scale	Steel	Cuyahoga Hts.	Cuyahoga River	Mill Scale, Iron				60	Scale Pit, Settling	12		38
Walker China Company	Ceramics	Bedford Hts.	Tinkers Creek	Susnended Solids				134	Settling		.007	39
Weather-Tite of Cleveland, Division of Pacific Coast Company	Metal Doors, Sash, Frames and Trim	Walton Hills	Trib. of Tinkers Creek	Acids, Aluminum, Suspended Solids					Neutralization, Settling			40
S.K. Wellman, Div., Abex Corp.	Automobile Parts	Bedford	Tinkers Creek	Acids, Heavy Metals				20	Neutralization, Settling	.08		41
Zirconium Corp. of America	Non-Clay Refractories	Solon	Trib. of Tinkers Creek	Suspended Solids, Metals, Chemicals					Neutralization, Settling			42
Ohio Drum Reconditioning	Drum Reconditioning	Cleveland	Big Creek	Oils, Solvents, Paints, Caustics					None	.04		43
Geauga County												
Cormax Metal Treating, Inc.	Primary Metal Products, Heat Treating	Burton	Trib. of Cuyahoga River	Cyanides, Oil, Color					Cyanide Oxidation, Settling	.005		44
Johnson Plastic Company	Extruded & Molded Plastic Material	Auburn Twp.	Bridge Creek, Cuyahoga River	Oils, Solids					None	Minor		45
Johnson Rubber Company	Extruded & Molded Rubber Material	Middlefield	Cuyahoga River	Oils, Heavy Metals					Separators, Controlled Release			46
Middlefield Swiss Cheese Co-Op	Cheeses, Milk	Middlefield	Underground Trib. of Cuyahoga River	Oxygen Demand, Suspended Solids					Whey Land Disposal		.002	47
Smallwood Packing Company, Inc.	Meat Packing	Middlefield	Groundwater of Cuyahoga River	Oxygen Demand, Suspended Solids					Settling, Aerobic Lagoons			48
Portage County												
Flintkote Company, Pipe Products Group	Asbestos Products	Ravenna	Breakneck Creek	Acids, Suspended Solids					Chemical Treatment, Lagoons	.86	1.44	49

Table II-10 (Cont'd.)

Inventory and Treatment Data
Industries and Other Systems
in the Cuyahoga Basin

Name of Industry	Type	Location	Receiving Stream	Critical Waste Constituents	Wastewater Characteristics - mg/l - Raw BOD	Raw SS	Effluent BOD	Effluent SS	Treatment Provided	Hydraulic Loading - mgd - Current Flow	Design Flow	Ident. No.
Hilltop Sand and Gravel Company	Sand and Gravel	Kent	Trib. to Little Cuyahoga River	Suspended Solids					Settling			50
Pettibone Sand and Gravel Company	Sand and Gravel	Mantua	Cuyahoga River	Suspended Solids					Settling	1.440		51
Lamson and Sessions Company	Bolts, Nuts, Screws, Rivets, Washers	Kent	Cuyahoga River	Acids, Oils					Flotation, Controlled Release	.003	.001	52
Procex, Inc.	Metal Cleaning	Kent	Plum Creek	Acid, Oil, Suspended Solids, Dissolved Solids					None			53
Summit County												
Akron Packing, Co., Inc.	Meat Packing	W.Richfield	Land Disposal, Trib. of North Fork	Oxygen Demand, Suspended Solids					Aerobic Treatment		.01	54
Alside, Inc.	Sheet Metal Work	Akron	Mud Brook	Sanitary Wastes					Aeration Unit		San .009 Ind. .040	55
Busson Brothers Sand and Gravel	Sand and Gravel	Ghent	Yellow Creek	Suspended Solids					None			56
Consolidated Freightways	Truck Washing	W.Richfield Township	Trib. of Cuyahoga River	Acids, Organics, Oil, Suspended Solids					Chemical Treatment, Aeration, Stabilization		.015	57
Cornwell Quality Tools Co.	Hand and Edge Tools, Metal Finish	Mogadore	Trib. of Cuyahoga River	Acids, Chrome					Controlled Discharge		.144	58
Goodyear Aerospace Corporation	Aircraft Parts & Auxiliary Equipment	Akron	Trib. of Little Cuyahoga River	Acids, Alkalies, Oil, Suspended Solids, Heavy Metals					Settling, Some Wastes Tributary to Akron	2.16		59
Goodyear Tire and Rubber Company	Tires and Inner Tubes	Akron	Little Cuyahoga River	Oxygen Demand, Organics Suspended Solids, Oils			100	40	Settling, Separation	14.4		60
Lerkis Asphalt Company	Paving Mixtures	Akron	Little Cuyahoga River	Acids, Iron, Suspended Solids					Settling		.13	61
M&M Sand and Gravel Company	Sand and Gravel	Akron	Camp Brook-Little Cuyahoga River	Suspended Solids					Settling		.25	62
Mohawk Rubber Company	Tires and Inner Tubes	Akron	Little Cuyahoga River	Suspended Solids, Oil, Oxygen Demand					None			63
Ohio Edison Co., Gorge Plant	Power	Akron	Cuyahoga River	Suspended Solids, Heat					Settling	Fly Ash Pond .003	.002	64
Sonoco Products Co., Ohio Division	Paper Mill	Munroe Falls	Cuyahoga River	Oxygen Demand, Suspended Solids			120	250	Aerated Lagoons	.48		65
Akron, Canton & Youngstown Railroad	Railroad Yard	Akron	Little Cuyahoga River	Oil					None			66

Table II-10 (Cont'd.)

Inventory and Treatment Data
Industries and Other Systems
in the Cuyahoga Basin

Name of Industry	Type	Location	Receiving Stream	Critical Waste Constituents	Wastewater Characteristics - mg/l - Raw BOD	Raw SS	Effluent BOD	Effluent SS	Treatment Provided	Hydraulic Loading - mgd - Current Flow	Design Flow
Summit County (These industries discharge to the Ohio Canal, which at times is tributary to the Little Cuyahoga River).											
Diamond Crystal Salt Company	Chemicals	Akron	Ohio Canal	Chlorides				Chlorides 870	Some Tributary to Municipal, Cooling	2.88	
Firestone Tire and Rubber Company											
Xylos Plant and Plant #1	Reclaimed Rubber	Akron	Ohio Canal								
Synthetic Latex Plant	Synthetic Rubber	Akron	Ohio Canal								
Ammunition Plant	Small Arms Ammo.	Akron	Ohio Canal								
Plant #1 and Plant #2	Tires and Inner Tubes	Akron	Ohio Canal	Oils, Grease, Soapstone, Oxygen Demand, Organics, Suspended Solids					Some Tributary to Municipal System	45	
B.F. Goodrich	Tires and Inner Tubes	Akron	Ohio Canal	Oils, Oxygen Demand, Organics, Suspended Solids					Sumps and Separators		
B.F. Goodrich Company, Chemical Division	Synthetic Rubber	Akron	Ohio Canal	Total Solids, Suspended Solids, Oxygen Demand, Odor					Exempt Oct. 1969		

Table II-10 (Cont'd.)

Inventory and Treatment Data
Industries and Other Systems
in the Chagrin Basin

Name of Industry	Type	Location	Receiving Stream	Critical Waste Constituents	Wastewater Characteristics Raw - mg/l BOD	Raw SS	Effluent BOD	Effluent SS	Treatment Provided	Hydraulic Loading Current Flow - mgd	Design Flow	Ident. No.
Cuyahoga County												
Chase Bag Co., Paper Mill Division	Paper Mill	Chagrin Falls	Chagrin River	Oxygen Demand Suspended Solids			33	90	1. Filtration 2. Coagulation and Settling w/discharge to Municipal Plant	1.8		74
Geauga County												
General Biochemicals Div. of North American Mogul Prod. Co.	Medicinal Chemicals and Botanical Prod.	Bainbridge Twp.	Chagrin River (via ditch)	Acids, Suspended Solids					Neutralization, Settling, Controlled Discharge	.001		75
Mulberry Sand and Gravel Co.	Sand and Gravel	Chesterland	E.Branch of Chagrin River	Suspended Solids					Settling			76
Lake County												
Cleveland Electric Illuminating	Power	Eastlake	Lake Erie near Chagrin River	Solids, Temperature				300	Settling			77
Lubrizol Corporation	Chemicals and Chemical Preparations	Wickliffe	Lake Erie from Lloyd Road Sewer	Oils, Oxygen Demand, Odors, Color, pH	200		50	40	Settling, Oil Removal Aerated Lagoons	.2	.11	78
Portage County												
Pennsylvania Glass Sand Corp. Industrial Silica Division	Sand and Gravel	Geauga Lake	Trib. of Chagrin River	Suspended Solids					Settling		.36	79
Custom Beverage Packers, Inc.	Bottled and Canned Soft Drinks	Aurora	Small Stream - Sunny Lake	Oxygen Demand, Acids	1300	200	80	150	Five Stage Lagoon	.03	.16	80

Table II-10 (Cont'd.)

Inventory and Treatment Data
Industries and Other Systems
in the Rocky Basin

Name of Industry	Type	Location	Receiving Stream	Critical Waste Constituents	Wastewater Characteristics Raw - mg/l - BOD	Raw SS	Effluent BOD	Effluent SS	Treatment Provided	Hydraulic Loading Current Flow - mgd	Design Flow	Iden No.
Cuyahoga County												
Donn Products, Inc.	Aluminum Sheet Metal Works	Westlake	Porter Creek to Lake Erie	Acids, Suspended Solids, Heavy Metals					Chemical Treatment, Settling, Aeration		.003	81
General Motors Corp.; Allison Division, Cleveland Ordinance Plant	Tanks and Tank Components	Brookpark	Abrams Creek Trib. of Rocky River	Acids, Oils, Heavy Metals					Neutralization, Cyanide Oxidation, Chrome Reduction		.72	82
National Aeronautical and Space Administration	Research	Brookpark	Rocky River	Acids, Oils, Heavy Metals					Oil Separators, Settling			83
Medina County												
Farm Packt Pickle Co., Inc.	Pickled Fruits and Vegetables	Montville Twp.	W. Branch Rocky River	Oxygen Demand, Chlorides, Suspended Solids					Lagoon		1.74	84
Modern Tool and Die Company	Metal Stamping	Valley City	W. Branch Rocky Ri er	Oils, Acids, Metals					Sand Filter		.072	85

TABLE II-11

MAJOR INDUSTRIES TRIBUTARY TO
NAVIGATION CHANNEL OF THE CUYAHOGA RIVER

Industry	Discharge Location	Flow - MGD
Allied Chemical	Mill Creek	
Alloys Chemicals Corporation	Cuyahoga River	.621
Burdett Oxygen Company	Cuyahoga River	.004
Cleveland Cap & Screw Company	Cuyahoga River	.235
Cuyahoga Meat Company	Big Creek	.018
Dupont, E.I. de Nemours (Proc)	Cuyahoga River	1.66
(Cooling)	Cuyahoga River	
Elco Corporation	Cuyahoga River	.025
Ford Motor - Cleve. Foundry	Big Creek	
- Engine Plant 1	Big Creek	.247
- Engine Plant 2	Big Creek	.582
General Motors - Chevy Division	Big Creek	.678
Harshaw Chemical	Cuyahoga River	1.896
J.L. Steel - Cleveland Works	Cuyahoga River	131
Modern Tool & Die Company	Big Creek	.493
Republic Steel - Bolt & Nut Div.	Cuyahoga River	2.66
- Cleve. Dist.	Cuyahoga River	200
River Smelting & Refining Company	Cuyahoga River	.034
Standard Oil Co. - Refinery #2	Kingsbury Run	.405
U.S. Steel - Central Furn.	Cuyahoga River	586
- Cuyahoga Div.	Cuyahoga River	12.4
International Salt	Cuyahoga River	.981
Metals Applied, Inc.	Cuyahoga River	.044
State Fish Company	Cuyahoga River	.019
Clifton Concrete	Cuyahoga River	.013
Darling & Company	Cuyahoga River	.045
Cuyahoga Soap	Cuyahoga River	.045
Bradley Metal Company	Cuyahoga River	.060

Twelve hours is close to the basin lag time and also gives some consideration to the movement of the storm across the basins. The design storms are shown on the following table:

TABLE II-12

DESIGN STORMS

Frequency	Inches Per Three Hour Period 1st Period	2nd Period	3rd Period	4th Period	Total
1-Year	.263	.612	.612	.263	1.75
5-Year	.40	.95	.95	.40	2.70
10-Year	.45	1.05	1.05	.45	3.00
25-Year	.52	1.20	1.20	.52	3.44
50-Year	.55	1.30	1.30	.55	3.70
100-Year	.65	1.52	1.52	.65	4.34

The amount of runoff is related to the impervious area of the basin. Estimates of the developed land and impervious land were made from current and future land-use maps, and these values are shown of Table II-13.

TABLE II-13

THREE RIVERS WATERSHED AREA
DEVELOPED AND IMPERVIOUS PERCENTAGES

Basin	Developed 1970	2020	% Impervious 1970	2020
Cuyahoga	35%	40%	13.3%	18.5%
Rocky	45%	60%	16.2%	22.8%
Chagrin	25%	30%	11.3%	14.0%

Soil infiltration capacity was assumed at 0.15 inch/hr. or 0.45 inch/3 hr. period. Excess rainfall from each 3-hr. period would be rainfall depth minus 0.45 inch from previous areas, plus runoff from impervious areas. Using this excess rainfall from four 3-hr. periods, hydrographs for various

frequencies of occurance were computed. Peak rates of discharge and volume of runoff are summarized in Table II-14.

For area of East Cleveland, West Cleveland and West Cuyahoga County, no hydrograph was computed since this area has many outlets to Lake Erie, but volumes of runoff for various frequencies were computed utilizing the excess rainfall from each storm.

Table II-16 shows pollution loads from 1-Year and 5-Year storms for the year 1970, based on volumes of hydrographs from Table II-14 and the following concentrations in mg/l:

TABLE II-15

STORM RUNOFF CHARACTERISTICS

Suspended Solids	200 mg/l
BOD	30 mg/l
COD	10 mg/l
Chlorides	60 mg/l
Total Nitrogen as N	2.0 mg/l
Phosphorus as P	0.2 mg/l

Runoff from Sustained Average Stream Flow

The sustained average flow from streams and drains as used herein is made up of three sources: dry weather stream flow; urban runoff from combined sewer overflows and normal low-intensity precipitation; and runoff from rural areas due to low-intensity precipitation.

Dry Weather Stream Flows: The annual volume of stream flows was computed based on the rate of discharge that was equalled or exceeded 95% of the time. These flows (exclusive of wastewater flows) are stated as follows:

Chagrin River at Willoughby	23.7 cfs
Rocky River at Berea	3.6 cfs
Cuyahoga River at Independence	152 cfs

TABLE II-14

STORM RUNOFF HYDROGRAPHS SHOWING PEAK RATE AND VOLUMES FOR THE YEAR 1970

	1-Year		5-Year		10-Year		25-Year		50-Year		100-Year	
	Peak Rate, cfs	Volume Million c.f.	Peak Rate, cfs	Volume Million c.f.	Peak Rate, cfs	Volume Million c.f.	Peak Rate, cfs	Volume Million c.f.	Peak Rate, cfs	Volume Million c.f.	Peak Rate, cfs	Volume Million c.f.
Chagrin River	5,820	267	13,800	625	17,340	870	21,500	1,150	24,860	1,245	29,000	1,375
Rocky River	4,720	380	9,400	825	11,820	1,017	15,000	1,335	16,800	1,500	20,500	1,600
Upper Cuyahoga River*	2,270	440	4,750	1,020	6,283	1,300	8,000	1,620	9,300	1,950	11,250	2,400
Lower Cuyahoga River*	4,400	525	9,000	1,130	10,900	1,410	13,000	1,725	15,400	2,080	19,750	2,750
East Cleveland, West Cleveland and West Cuyahoga County	-	210	-	436	-	508	-	643	-	723	-	925

*To arrive at total discharge, Upper and Lower Cuyahoga figures are additive.

TABLE II-16

RUNOFF POLLUTION LOADS FROM
1-YEAR AND 5-YEAR STORM EVENTS

Basin	Volume Million c.f.	Loads in 1,000 lb./Storm Event: Suspended Solids	BOD	COD	Chloride Cl	Total Nitrogen N	Total Phosphate P
1-Year Storm (Year 1970)							
Chagrin	267	3,333	50	166	1,000	33	3.3
Rocky	380	4,744	71	237	1,423	47	5
Cuyahoga	965	12,048	180	602	3,614	119	12
Misc. Areas	210	2,621	40	131	786	26	2.6
SUB-TOTAL	1,822	22,746	341	1,136	6,823	226	22.9
5-Year Storm (Year 1970)							
Chagrin	625	7,803	117	390	2,340	77	8
Rocky	825	10,300	154	515	3,090	102	10
Cuyahoga	2,150	26,843	402	1,342	8,052	267	27
Misc. Areas	436	5,443	81	272	1,632	54	5
TOTAL	4,036	50,389	754	2,519	15,114	500	50

Concentrations of pollutants in the dry weather flows derived from laboratory analyses are as shown in Table II-17. These concentrations were adjusted to exclude municipal or industrial wastes currently discharged to rivers, which were accounted for in the municipal and industrial loads tabulations.

TABLE II-17

DRY WEATHER FLOW - CONCENTRATION OF POLLUTANTS
(Figures in mg/l)

	T.S.	S.S.	BOD	COD	SO_4	Cl.	N	P
Chagrin	352	127	2	5	65	35	.8	.2
Rocky	451	45	2	5	65	35	.8	.2
Cuyahoga	643	26	2	5	65	35	.8	.2

Urban Runoff: Extensive investigations were made concerning runoff factors and impervious ratios in Cleveland during preparation of the Cleveland Master Plan studies. From these data it was found that the mean runoff factor for urban Cleveland was 0.54 times the percentage of imperviousness. This factor was applied to total annual rainfall depth of 35.5 inches to obtain the total volume of runoff from urban areas.

Concentrations of pollution parameters used for urban runoff were as follows:

TABLE II-18

URBAN RUNOFF CHARACTERISTICS

Suspended Solids	30 mg/l
BOD	15 mg/l
COD	35 mg/l
Chlorides	161 mg/l
Total Nitrogen as N	3.1 mg/l
Phosphorus as P	0.7 mg/l

Since overflows from combined sewers have higher pollution concentrations, an incremental load from combined sewers areas is added to obtain total urban runoff load. There is a total combined sewer area of 45,164 acres in Greater Cleveland. Concentrations of combined sewer overflows obtained from analyses in Cleveland are as follows:

TABLE II-19

COMBINED SEWER OVERFLOWS

Suspended Solids	126 mg/l
BOD	58 mg/l
COD	218 mg/l
Chlorides	161 mg/l
Total Nitrogen as N	12 mg/l
Phosphorus as P	8 mg/l

Rural Runoff: Runoff from pervious rural areas will occur only when soil infiltration capacity is exceeded. Infiltration capacity was selected at .15 inch/hr. and the annual rainfall that exceeds this rate was found to be approximately 12 inch/year or 33.7% of total annual rainfall. It was assumed that 25% of this excess rainfall will find its way to streams, so that the net runoff from pervious areas will be equal to 8.4% of total annual rainfall.

Pollution parameters concentrations for rural storm runoff are as shown in the following table:

TABLE II-20

RURAL STORM RUNOFF

Suspended Solids	200 mg/l
BOD	3.0 mg/l
COD	10 mg/l
Chlorides	60 mg/l
Total Nitrogen as N	2.0 mg/l
Phosphorus as P	0.2 mg/l

The pollution loadings originating from all three sources (sustained stream flow, urban runoff, combined sewer overflows, and rural runoff) were calculated from the data presented in the foregoing tabulations, and are summarized in Table II-21.

TABLE II-21

TOTAL ANNUAL RUNOFF POLLUTION LOADS

Basin	Annual Volume (Mill.C.F.)	Total Solids	Suspended Solids	BOD	COD	Sulfate SO4	Chloride Cl	Total Nitrogen N	Total Phosphate P
		Pollution Load in 1,000 Pounds Per Year							
Dry Weather Stream Flows (Year 1970) (1)									
Chagrin	747	16,367	5,905	93	233	3,031	1,632	37	9
Rocky	114	3,200	319	14	35	462	249	6	2
Cuyahoga	4,793	191,839	7,757	598	1,496	19,449	10,472	239	60
Misc. Area	2,050	81,900	6,266	1,200	7,784	8,320	8,960	490	96
Sub-Total	7,704	293,306	20,247	1,905	9,548	31,262	21,313	772	167
Urban Storm Runoff (Year 1970)									
Chagrin	1,341	N.A.	2,510	1,255	2,930	N.A.	13,478	259	58
Rocky	2,106		3,942	1,971	4,601		21,167	407	92
Cuyahoga	4,753		8,897	4,448	10,385		47,771	919	207
Misc. Areas	1,478		2,766	1,383	3,229		14,855	286	64
Incremental Load from Combined Sewer Areas (2)	Included in above		11,630	6,165	20,760		4,646	1,328	1,036
Sub-Total	9,678		29,745	15,222	41,905		101,917	3,199	1,457
Rural Storm Runoff (Year 1970)									
Chagrin	1,627	N.A.	20,313	304	1,016	N.A.	6,093	201	20
Rocky	1,695		21,162	317	1,058		6,348	210	21
Cuyahoga	4,887		61,014	914	3,051		18,302	606	61
Misc. Areas	690		8,614	129	431		2,584	85	9
Sub-Total	8,899		111,103	1,664	5,556		33,327	1,102	111
TOTAL	26,281		161,095	19,151	57,009		156,557	5,073	1,735

NOTES: (1) Dry Weather Flow Pollution Loads do not include Municipal or Industrial wastes currently discharged to river; these loads were included in municipal and industrial waste tables. (2) Incremental load from combined sewer overflows is due to the higher concentrations of pollution in overflow discharges.

C. CURRENT WASTEWATER MANAGEMENT PLANNING

Inadequacies of the present wastewater collection and treatment facilities have received renewed attention in the recent past due to awakened public interest, subsequent governmental institution of water quality standards, and tightening of wastewater regulations. The various public agencies in the Three Rivers Watershed have environmental engineering projects currently underway or planned within the 1970-1980 decade. Table II-22 lists the municipality, township or other agency and those projects presently planned for the 1970-1980 decade.

Table II-23 lists the activities planned for this area which are expected to be implemented within the next five years.

The table showing the projects planned for the 1970-1980 decade is basically a summary of the first decade plan of the Northeast Ohio Water Development Plan currently being prepared by the Department of Natural Resources, State of Ohio.

TABLE II-22

PROJECTS PLANNED FOR THE 1970-1980 DECADE

Lower Cuyahoga River Basin

Area	
1. Ravenna City	Expand plant and add tertiary treatment plus positive disinfection.
2. Kent City	Alternate 1 - Accept waste from outside areas with Kent the regional plant. Alternate 2 - Work with outside areas and become part of a regional system, with two plants, Kent plus a second plant nearby with interconnecting facilities.
3. Portage County Brimfield and Franklin Townships	Continue as presently planned to bring about a regional system at Kent.
4. Ravenna and Rootstown	Continue as presently planned to bring about a regional system at Ravenna.
5. Akron	Add tertiary treatment and nitrification.
6. Hudson	Connect to Macedonia S.D. 15.
7. Macedonia S.D. 15	Expand, add tertiary treatment.
8. Brecksville, Cuyahoga County	Cleveland Southerly via CVI*
9. Northfield Village	Cleveland Southerly via CVI*
10. Greenwood	Cleveland Southerly via CVI
11. Seven Hills	Cleveland Southerly via CVI
12. Broadview	Cleveland Southerly via CVI
13. Maple Heights	Cleveland Southerly via CVI*
14. Bedford	Cleveland Southerly via CVI*
15. Oakwood	Cleveland Southerly via CVI
16. Walton Hills	Cleveland Southerly via CVI*
17. Nagy Estates	Cleveland Southerly via CVI

*May require immediate improvement prior to construction of CVI.

TABLE II-22 (Cont'd.)

Lower Cuyahoga River Basin (Cont'd.)

Area	
18. Hawthornden State Hospital	Cleveland Southerly via CVI
19. Bedford Heights	Continue as an individual plant.
20. Solon	Continue as an individual plant.
21. Twinsburg	Become a temporary regional plant, add tertiary and positive disinfection.
22. Aurora Plants	Combine with Twinsburg
23. Streetsboro Plant	Combine into a temporary regional plant near Hudson Township #5.
24. Richfield	Temporary tertiary treatment plant serving Richfield discharging to the Cuyahoga River.
25. Hudson Township #6	Continue with individual plant with tertiary treatment.
26. Cleveland Southerly	Increase capacity, add tertiary treatment with nitrification.
27. Cleveland Metro Sewer System, downstream of Harvard Road	Improve sewer system to reduce combined sewer overflows.
28. Twin Lakes	Construct individual plant with tertiary treatment.
29. Fish Creek	Pump to Kent

Upper Cuyahoga River

1. Chardon-Windsor	No development.
2. Butternut Creek - Lake Aquilla	Start sewer program at Lake Aquilla.
3. Silver Lake - East Claridon	No development.
4. Burton	Expand existing plant and add tertiary treatment.
5. Middlefield	Expand existing plant and add tertiary treatment.

TABLE II-22 (Cont'd.)

Upper Cuyahoga River (Cont'd.)

Area	
6. Auburn-Troy	No development.
7. Mantua	Addition of tertiary treatment.
8. Shalersville	No development.

Chagrin River Basin

1. *Willoughby-Eastlake*	*Continue plans for expansion of existing plant* and the addition of nutrient removal. Start construction of major interceptor.
2. Chagrin Falls Area (Chagrin Falls)	Continue plans for present plant expansion. Plan sewer capacity for long term plan. Add tertiary treatment and positive disinfection.
Chagrin Falls Area (Geauga County - Fairmount Road)	Construct plant as planned by County Sanitary Engineer. Tertiary treatment and positive disinfection should be included.
3. McFarland Creek	Construct plant as planned by County Sanitary Engineer. Tertiary treatment and positive disinfection should be included.
4. Pepper Pike Area	Operate existing plants until phased out by Cleveland N.E. Interceptor System.
5. Aurora Area	Continue with existing Aurora central plant. Add tertiary and positive disinfection.
6. East Branch, Chardon Township	No development.
7. Fowlers Mill Area	Construct two small plants; one at Fowlers Mill and one at Bass Lake.
8. Newbury Township	No development.

Rocky River Basin

1. Lakewood	Expand plant and add tertiary treatment.
2. Rocky River	Expand plant as presently planned.
3. North Olmsted	Enlarge plant, add tertiary treatment, as presently planned. To serve as temporary regional plant serving Olmsted Township, Olmsted Falls, Columbia Township and Strongsville "A" area.

TABLE II-22 (Cont'd.)

Rocky River Basin (Cont'd.)

Area	
4. Berea	Add tertiary to present plant. To serve as temporary regional plant serving Berea only.
5. Middleburg Heights	Continue present plant; add phosphate removal. To serve as temporary regional plant, treating excess flows from Brookpark.
6. Brookpark	Continue to operate existing plant at design flow of 1 mgd. Pipe excess flow to Middleburg Heights. Add phosphate removal.
7. Strongsville "B" & "C" North Royalton "A" & "B"	Continue operation. Provide 90-95% removal, adding tertiary treatment if necessary. Provide positive disinfection.
8. Medina County S.D. 100	Continue operating, add tertiary treatment.
9. Medina City	Improve as planned; provide tertiary treatment.
10. Medina County 5	To be replaced by Medina County regional plant.
11. Strongsville "A"	Alternate 1 - Enlarge plant to 2 mgd and construct sewer to Berea for flows in excess of 2 mgd plus sludge. Alternate 2 - Phase out, with sewer to North Olmsted regional in cooperation with Olmsted Falls.
12. Medina County 7 & 11	Combine into new plant near Ridge Road and East Branch of Rocky River. Provide tertiary and positive disinfection.

Lake Erie

1. Cleveland Westerly	Continue as a regional plant. Construct new plant as planned with tertiary treatment and nutrient removal.
2. Cleveland Easterly	Continue as a regional plant with enlargement and combined sewage treatment as planned. Tertiary treatment and phosphorus reduction to be increased. Add outfall.
3. Euclid	Continue as a regional plant. Construct enlargements as planned with tertiary treatment and phosphorus addition to be increased.

TABLE II-23

PROJECTS SCHEDULED TO BE IMPLEMENTED WITHIN NEXT FIVE YEARS

Lower Cuyahoga River Basin

1. Expansion of the plant at Ravenna.
2. Portage County - construction proceeding toward the regional plants at Kent and Ravenna.
3. Akron - sludge treatment facilities advanced waste treatment, phosphate removal, and disinfection.
4. Macedonia S.D. 15 - plant expansion.
5. Construction of the Cuyahoga Valley Interceptor.
6. Twinsburg - plant expansion.
7. Streetsboro - construction of the regional plant.
8. Richfield - individual plant construction.
9. Hudson Township No. 6 - expansion of present plant with tertiary treatment and disinfection.
10. Cleveland Southerly - expansion of plant, add nutrient removal, tertiary treatment.
11. Twin Lakes - construction of small plant with tertiary and disinfection.
12. Fish Creek - force mains to Kent Plant.
13. Construct Cuyahoga Valley Interceptor, S.W. and Broadway Express Sewers.

Upper Cuyahoga River Basin

1. Burton - expand existing plant with tertiary treatment and disinfection.
2. Middlefield - expand existing plant with tertiary treatment and disinfection.

Chagrin River Basin

1. Willoughby-Eastlake - expand to secondary treatment with phosphate removal.
2. Chagrin Falls - construct new plant.

Rocky River Basin

1. Rocky River - expand plant, add secondary treatment and nutrient removal.

TABLE II-23 (Cont'd.)

Rocky River Basin (Cont'd.)

2. North Olmsted - expand plant adding tertiary treatment.

3. Strongsville "A" - join North Olmsted.

Lake Erie

1. Cleveland Westerly - construct new advanced wastewater treatment plant.

2. Cleveland Easterly - expand plant adding tertiary treatment, phosphate removal, disinfection, and storm water treatment.

3. Euclid - expand plant adding tertiary treatment, and phosphate removal.

4. Construct Heights Express Sewer.

D. COMPARISON OF WATER QUALITY WITH PRESENT WATER QUALITY STANDARDS

All of the major rivers and their tributaries within the study area are polluted to some degree, as is Lake Erie. Failure to meet established water quality standards occurs with varying frequency and severity at different points within the watershed; the headwaters and tributaries meet most of the reauired criteria most of the time, while the lower reaches of the main rivers fail to meet several criteria most of the time. In this section, present water quality is described and compared to present water quality standards in various portions of the basin. The descriptions are based on detailed data obtained from previous studies, not presented in this brief report.

Applicable water quality standards established by the Ohio Department of Health and EPA are summarized in Table II-24, and the full standards are in attachment 2.

Upper Cuyahoga River - The reach of the Cuyahoga and its tributaries north of Kent, (upstream of Lake Rockwell Dam) is described here as the Upper Cuyahoga Basin. Virtually all of the stream water in the basin is unpolluted or in a recovered zone classification. Due to dilution and assimilation, the effect of the few treated wastewater effluents is minor in most of the stream reaches. Water Quality Standards for all uses are met most of the time.

Lower Cuyahoga River - From Lake Rockwell to Lake Erie, the river and its tributaries are designated as the Lower Cuyahoga Basin. None of the reaches below Lake Rockwell meet criteria for partial body contact.

The reach from Lake Rockwell to Kent Wastewater Treatment Plant is Aquatic Life "A" in quality to the confluence with a major tributary, Breakneck Creek. This stream varies in quality, achieving Aquatic Life "A" standards only during high flow periods. The effects of municipal effluents

reduce quality during low flows. The effect of Breakneck Creek is important because of its relatively high percentage of discharge entering the Cuyahoga after most of the Cuyahoga flow is diverted into the Akron Water Supply at Lake Rockwell. Below this confluence to Kent, the Cuyahoga meets chemical and physical parameters, but stream biology does not reflect Aquatic Life "A" quality in the remainder of the reach.

The reach from Kent to Munroe Falls Dam is a flowing pool rich in effluent nutrients. Algae blooms are frequent in summer and the pool depths are deficient in dissolved oxygen. This reach does not meet established Aquatic Life "A" standards. Retention time and assimilation in the pool improve water quality considerably as measured in the reach below the dam.

The reach from Munroe Falls to the end of the Cuyahoga gorge has a gradient of 210 feet in 5.5 miles. The original rapids and cataract stream course has been modified by several low and one high dam. Dissolved oxygen is high, and meets the established criteria for Aquatic Life "A". The pool at the 80 foot high Ohio Edison Power plant dam receives a high thermal and solids load. Dissolved oxygen is very low in the pool water, and settling of the solids occurs in the pool. Dissolved oxygen is restored in the fall over the dam.

The reach from the gorge below Ohio Edison dam to the Little Cuyahoga confluence meets Aquatic Life "A" criteria.

The Little Cuyahoga River flows through Akron and carries concentrations of dissolved and suspended solids. Oil is a frequent pollutant. Color, odor and high turbidity are frequent problems. Toxicity tests in 1967 were positive. The water entering the Cuyahoga is a poor quality Industrial Water.

The reach from the Little Cuyahoga confluence to the Akron Wastewater Treatment Plant is Aquatic Life "B", as measured by biological parameters.

Chemical and physical parameters for Aquatic Life "A" are met part of the time.

The reach from the Akron Wastewater Treatment Plant to Furnace Run receives the impact of 65 to 70 mgd of effluent, including quantities of settleable and unstabilized organic matter. Anaerobic decomposition is a major problem in this reach below the plant's effluent outfall. The usually expected biological indicators, such as sludgeworms and midge larvae are generally absent or low in numbers in most samples, further attesting to this troublesome effluent. The river in this reach meets none of the criteria for any uses. Criteria is Aquatic Life "B" to 1975 and Aquatic Life "A" thereafter.

The reach from Furnace Run to the Cleveland Southerly Wastewater Treatment Plant is a long extended zone of recovery. Toxic conditions for some aquatic organisms occur throughout the reach. Fish and truly aquatic invertebrates other than the most tolerant forms, do not establish populations in the river. Typical recovery reach algae are not abundant as would usually be expected in nutrient rich water. The reach does not meet the established Aquatic Life "A" criteria.

The major tributary to this reach is Tinkers Creek, which receives municipal loads at several points along its entire course. Assimilative characteristics are excellent due to high gradient sections that maintain satisfactory dissolved oxygen levels in the lower reaches of the stream. However, treatment plant effluent loads are large in the lower reaches, and during low flow periods make up 70-90 percent of the total flow. As a result, solids, BOD and coliform counts remain high in spite of good dissolved oxygen levels. The stream biology is poor in diversity. The water does not meet the established Aquatic Life "A" standards.

The downstream reach of the Cuyahoga from the Cleveland Southerly Treatment Plant to the mouth is grossly polluted. In addition to the treatment plant effluents, discharges include industrial waste flows, combined sewer overflows, and polluted tributary streams (such as Kingsbury Run). The river water is high in COD, solids, ammonia, phosphate, dissolved solids, oils, and metals. Water is grey, odorous, and septic; dissolved oxygen is near zero during the summer low flow periods. Iron and other metals form precipitates which settle to the bottom together with organic solids. This sludge sediment undergoes anaerobic decomposition at low rates, releasing gases, and part of these solids are washed into Lake Erie during periods of heavy runoff. Much of the sediment is removed from the navigation channel by dredging. Floating debris and oil is present in large quantities, particularly after storms. Almost no biological life exists in this reach, and the water does not meet the standards for any use.

Rocky River - The West Branch and North Branch headwaters upstream from their confluence and the Medina City Water Treatment Plant are used for public water supply. The water is stored in an off-channel reservoir. Selective pumping avoids unsuitable water during some periods. The West Branch below the addition of effluent from the Medina Wastewater Treatment Plant does not generally meet the criteria for dissolved oxygen and solids for Aquatic Life "A". Coliform counts are high. Additional effluent inputs along the entire length prevent a completed recovery zone for the entire length of the West Branch. Dissolved oxygen reaches saturation in extended riffles.

East Branch - The headwaters of the East Branch are, in general, clean. One small private treatment plant and some septic wastes enrich the upper East Branch, but assimilative characteristics are high and the stream biology and chemical criteria indicate that the water meets Aquatic Life "A" standards.

The overflow at Hinckley Lake dam with chlorination meets Full Body Contact Recreation standards and is used for swimming. Some tributaries downstream carry effluent from very small private and county operated wastewater plants. The effect at present is minimal. The remainder of the East Branch of Rocky River above Berea meets Aquatic Life "A" standards except for dissolved oxygen deficiencies in some pools during low flow periods.

At Berea the East Branch is impounded by a dam and the water is used as Public Water Supply. The discharge and storage barely meet demand at present. Below Berea the stream receives 2 mgd of secondary effluent from the Berea treatment plant which, when combined at the confluence with the West Branch and subsequent wastewater treatment plant loads, passes through repeated zones of recent pollution and recovery. None of these reaches completely meets established Aquatic Life "A" standards in the stream course to Lake Erie. Where dissolved oxygen is sufficient in and at the foot of riffles, fish are found especially during high flows.

Chagrin River - The headwaters of the Aurora Branch meet Aquatic Life "A" standards as does the remainder of the stream to the Main Stem confluence except for short reaches below the Aurora and Solon Wastewater Treatment Plants.

The Main Stem headwaters flow through a very low gradient reach and where soil and stream organic matter is abundant, the water has a natural low dissolved oxygen content. The downstream reaches have a higher gradient and falls with good reaeration properties. Industrial and municipal loads reduce the stream quality at Chagrin Falls just above the confluence with the Aurora Branch. The stream gradient continues favorable to good reaeration in the remainder of the river. However, some long pools show low dissolved oxygen

levels, especially during low flow. The Main Stem meets Aquatic Life "A" standards during high flow periods but falls below in some reaches during low flows.

East Branch - This is basically a clean stream and meets Aquatic Life "A" standards throughout its length. It has a diurnal heating problem in the lower reaches where it is a shallow flow over shale bedrock for long reaches; water temperature attains 82°F on summer afternoons. The lower reach of the East Branch is used as Public Water Supply and meets these standards.

Lake Erie

The inshore waters of Lake Erie within the Three Rivers Watershed Area are polluted by four major sources of discharge. Polluted surface streams and drainage courses discharge bacterial contamination, COD, BOD, solids and debris. Combined sewer overflows discharge solids, raw sewage and bacterial pollution on an intermittent basis. Effluents from wastewater treatment plants discharge residual loadings of BOD, fine suspended solids and nutrients. Water entering the inshore zone from Cleveland Harbor carries residual polluting materials from the Cuyahoga River and combined sewer overflows located within the harbor zone. The inshore waters do not consistently meet standards for recreational waters or public water supply use.

The water within Cleveland harbor is affected by Cuyahoga River discharge, by combined sewer overflows and effluent from the Cleveland Westerly treatment plant. The harbor acts as a transition zone between the River and Lake Erie in which pollution loads are dispersed and partially reduced. In effect, the harbor acts as a natural treatment basin which plays a significant role in improving river water before it enters the lake.

E. CURRENT INSTITUTIONAL ARRANGEMENTS

1. AGENCIES PROVIDING WASTEWATER TREATMENT

At the present time in Northeast Ohio there are three major classes of agencies providing wastewater treatment. First, the local cities can provide this utility service under the constitutional home rule right. Under the Ohio Constitution, a community may decide upon its method of wastewater treatment and to provide this treatment in such a manner as it sees fit. It can, if desired, contract this service to other municipalities or it can contract with other municipalities to have them provide this service.

The second agencies that provide wastewater treatment facilities are the County sanitary engineering departments. The County can set up sewer districts or can contract with municipalities to provide wastewater treatment service. There is some question as to whether or not the County can operate and maintain sewage plants for individuals, such as trailer parks or small developments. However, in many areas the County is doing this, with the ownership of the facility being maintained by the other party.

The third major agency with capability to provide wastewater treatment is the Ohio Water Development Authority. To date, this agency has not constructed any plant with the intention of operating the facility itself, but has acted principally as a financing agency. However, under the Ohio law, the Authority has the right to operate and maintain the works as well.

Ohio law also permits the formation of Water and Sewer Districts, but this type of agency has not received widespread acceptance.

The following tables show the major sewered areas and the institution providing wastewater treatment to the study area:

TABLE II-25

AGENCIES PROVIDING WASTEWATER TREATMENT

CUYAHOGA RIVER WATERSHED

Political Subdivision	Major Wastewater Treatment Provided By	Tributary To
Cuyahoga County:		
Beachwood	Individual Systems	
Bratenahl	Easterly	Lake Erie
Cleveland	Easterly, Westerly and Southerly	Lake Erie, and Cuyahoga River
Cleveland Heights	Easterly	Lake Erie
East Cleveland	Easterly	Lake Erie
Euclid	Euclid	Lake Erie
Highland Heights	Easterly	Lake Erie
Lyndhurst	Easterly	Lake Erie
Richmond Heights	Easterly	Lake Erie
Shaker Heights	Easterly	Lake Erie
South Euclid	Easterly	Lake Erie
University Heights	Easterly	Lake Erie
Brooklyn	Southerly	Cuyahoga River
Solon	Solon Central	Tinkers Creek
Bedford Heights	Bedford Heights	Tinkers Creek
Brooklyn Heights	Southerly	Cuyahoga River
Cuyahoga Heights	Southerly	Cuyahoga River
Garfield Heights	Southerly	Cuyahoga River
Linndale	Southerly	Cuyahoga River
Maple Heights	Southerly; Maple Heights	Cuyahoga River
Newburgh Heights	Southerly	Cuyahoga River
North Randall	Southerly	Cuyahoga River
Parma	Southerly	Cuyahoga River
Parma Heights	Southerly	Cuyahoga River
Seven Hills	Southerly and Individual Systems	Cuyahoga River
Warrensville Heights	Cuyahoga County, Southerly	Cuyahoga River
Warrensville Twp.	Southerly	Cuyahoga River
Independence	Individual Systems	
Valley View	Individual Systems	
Walton Hills	Individual Systems	
Oakwood	Individual Systems	
Glenwillow	Individual Systems	
Brecksville	Cuyahoga County	Cuyahoga River
North Royalton	Individual Systems	
Orange	Individual Systems	
Broadview Heights	Individual Systems	
Bedford	Bedford	Tinkers Creek
Summit County:		
Sagamore Hills	Summit County and Individual Systems	Cuyahoga River

TABLE II-25 (Cont'd.)

AGENCIES PROVIDING WASTEWATER TREATMENT

CUYAHOGA RIVER WATERSHED (Cont'd.)

Political Subdivision	Major Wastewater Treatment Provided By	Tributary To
Summit County: (Cont'd.)		
Northfield	Northfield Plant	
Northfield Ctr. Twp.	Summit County	Cuyahoga River
Macedonia	Macedonia Plant	Brandywine Creek
Twinsburg	Twinsburg Plant	Brandywine Creek
Twinsburg Twp.	Twinsburg Plant	
Reminderville	Individual Systems	
Richfield Twp.	Individual Systems	
Peninsula	Individual Systems	
Boston Heights	Individual Systems	
Boston Township	Individual Systems	
Hudson	Hudson Plant	Cuyahoga River
Hudson Township	Summit County Plants	Cuyahoga River
Bath Township	Individual Systems	
Northhampton Twp.	Akron and Individual Systems	Cuyahoga River
Cuyahoga Falls	Akron	Cuyahoga River
Silver Lake	Akron	Cuyahoga River
Munroe Falls	Akron	Cuyahoga River
Stow Township	Akron	Cuyahoga River
Lakemore	Akron	Cuyahoga River
Springfield Twp.	Akron	Cuyahoga River
Fairlawn	Akron	Cuyahoga River
Akron	Akron Plant	Cuyahoga River
Tallmadge	Akron Plant	Cuyahoga River
Mogadore	Akron	Cuyahoga River
Stow	Akron	Cuyahoga River
Copley Township	Akron and Summit County	Cuyahoga River
Richfield	Individual Systems	
Geauga County:		
Burton	Burton Plant	Cuyahoga River
Middlefield	Middlefield Plant	Cuyahoga River
Hambden Township	Individual Systems	
Montville Twp.	Individual Systems	
Claridon Twp.	Geauga County and Individual Systems	Cuyahoga River
Huntsburg Twp.	Individual Systems	
Burton Township	Individual Systems	
Middlefield Twp.	Individual Systems	
Munson Township	Individual Systems	

TABLE II-25 (Cont'd.)

AGENCIES PROVIDING WASTEWATER TREATMENT

CUYAHOGA RIVER WATERSHED (Cont'd.)

Political Subdivision	Major Wastewater Treatment Provided By	Tributary To
Geauga County: (Cont'd.)		
Newbury Township	Individual Systems	
Auburn Township	Individual Systems	
Troy Township		
Portage County:		
Mantua	Mantua Plant	Cuyahoga River
Kent	Kent Plant	Cuyahoga River
Ravenna	Ravenna Plant	Congress Lake Outlet
Aurora		
Aurora Township		
Mantua Township		
Hiram Township		
Streetsboro Twp.	Streetsboro Plant	Tinkers Creek
Shalersville Twp.		
Franklin Twp.	Kent Plant	Cuyahoga River
Ravenna Township	Ravenna Plant	Congress Lake Outlet
Brimfield Twp.	Kent Plant	Cuyahoga River
Rootstown Twp.		
Suffield Twp.		
Randolph Twp.		
Lake County:		
Willowick	Euclid	Lake Erie
Wickliffe	Euclid	Lake Erie
Willoughby Hills		

CHAGRIN RIVER WATERSHED

Political Subdivision	Major Wastewater Treatment Provided By	Tributary To
Lake County:		
Kirtland Village	Individual Systems	
City of Mentor	Lake County	Lake Erie
City of Willoughby	Willoughby-Eastlake	Lake Erie
City of Eastlake	Willoughby-Eastlake	Lake Erie
Willoughby Hills	Lake County and Individual Systems	Chagrin River
Waite Hill	Individual Systems	
Kirtland Hills	Individual Systems	

TABLE II-25 (Cont'd.)

AGENCIES PROVIDING WASTEWATER TREATMENT

CHAGRIN RIVER WATERSHED (Cont'd.)

Political Subdivision	Major Wastewater Treatment Provided By	Tributary To
Cuyahoga County:		
Gates Mills	Individual Systems	
Mayfield	Cleveland Easterly	Lake Erie
Mayfield Heights	Cleveland Easterly	Lake Erie
Pepper Pike	Cuyahoga County and Individual Systems	
Hunting Valley	Individual Systems	
Woodmere	Individual Systems	
Orange	Individual Systems	
Moreland Hills	Individual Systems	
Chagrin Falls Twp.	Individual Systems	
Chagrin Falls	Chagrin Falls	Chagrin River
Solon	Solon	Aurora Branch
Bentleyville	Individual Systems	
Highland Heights	Cleveland Easterly	Lake Erie
Lyndhurst	Cleveland Easterly	Lake Erie
Beachwood	Cleveland Easterly	Lake Erie
Geauga County:		
South Russell Village	Geauga County and Individual Systems	Chagrin River
Russell Township	Geauga County and Individual Systems	Chagrin River
Newbury Township	Individual Systems	Chagrin River
Auburn Township	Individual Systems	Chagrin River
Bainbridge Twp.	Geauga County and Individual Systems	Chagrin River
Chardon Township	Geauga County and Individual Systems	
Chardon	Chardon	Grand River
Munson Township	Individual Systems	
Chester Township	Geauga County and Individual Systems	Chagrin River
Claridon Township	Individual Systems	
Portage County:		
Aurora	Aurora	Aurora Branch
Mantua Township	Individual Systems	
Shalersville Twp.	Individual Systems	
Streetsboro Twp.	Individual Systems	

TABLE II-25 (Cont'd.)

AGENCIES PROVIDING WASTEWATER TREATMENT

ROCKY RIVER WATERSHED

Political Subdivision	Major Wastewater Treatment Provided By	Tributary To
Cuyahoga County:		
Lakewood	Lakewood Plant	Rocky River
Rocky River	Cuyahoga County	Lake Erie
Fairview Park	Cuyahoga County	Lake Erie
(Old Parkview goes to North Olmsted - Rocky River)		
Westlake	Cuyahoga County	Lake Erie
Bay Village	Cuyahoga County	Lake Erie
Cleveland	Southerly	Cuyahoga River
Brookpark	Brookpark	Abrams Creek
North Olmsted	North Olmsted	Rocky River
Olmsted Township	Individual Systems and Cuyahoga County	Rocky River
Olmsted Falls	Individual Systems	
Berea	Berea	East Br., Rocky River
Middleburg Heights	Cuyahoga County	Abrams Creek
Strongsville	Strongsville	East Br., Rocky River
North Royalton	Districts A and B North Royalton	East Branch, Rocky River
Westview	Individual Systems	
Riveredge Township	Cleveland Southerly	Cuyahoga River
Parma	Cleveland Southerly	Cuyahoga River
Broadview Heights	Individual Systems	
Summit County:		
Richfield Twp.	Individual Systems	
Bath	Akron and Individual Systems	
Medina County:		
Liverpool Twp.	Individual Systems	
Brunswick Hills	Medina County	East and West Br. Rocky River
Brunswick	Medina County	East and West Br. Rocky River
Hinckley Twp.	Individual Systems and Medina County	
Granger Twp.	Individual Systems	
Medina Twp.	Individual Systems and Medina County	
Medina	Medina	West Br., Rocky River
York Township	Individual Systems	
Montville Twp.	Individual Systems	

TABLE II-25 (Cont'd.)

AGENCIES PROVIDING WASTEWATER TREATMENT

ROCKY RIVER WATERSHED (Cont'd.)

Political Subdivision	Major Wastewater Treatment Provided By	Tributary To
Medina County: (Cont'd.)		
Sharon Township	Individual Systems	
Lafayette Twp.	Individual Systems	
Litchfield	Individual Systems	
Chatham	Individual Systems	
Lorain County:		
Columbia Township	Individual Systems except West View Park Sub.	
Eaton Township	Individual Systems	
Grafton	Individual Systems	

2. AGENCIES PROVIDING DETAILED WATER RESOURCES PLANNING

In addition to the local planning done by each agency that treats wastewater within the area, there are agencies that provide overall regional planning for all or part of the study area. These are:

Department of Natural Resources, State of Ohio
Three Rivers Watershed District
Regional Planning Commission, Cuyahoga County
Tri-County Planning Commission

The plans of these agencies have been summarized in Part II-C of this report.

3. OHIO WATER POLLUTION CONTROL BOARD*

The "Water Pollution Control Act of Ohio," Sections 6111.01 to 6111.08 inclusive of the Revised Code, commonly referred to as the Deddens Act, was adopted by the 99th General Assembly of Ohio in 1951. This law, effective September 27, 1951, created a Water Pollution Control Board in the Ohio Department of Health with Powers, among others: to prevent, control, and abate new or existing pollution of the waters of the state; to issue, modify, or revoke orders for abatement of pollution and for construction of suitable facilities to prevent, control and abate pollution; to issue, revoke, modify or deny permits for the discharge of sewage and industrial wastes to waterways of the state; and to institute, or cause to be instituted, in common pleas courts having jurisdiction, proceedings to compel compliance with the provisions of the Act or with orders of the board. This law is considered fundamental in establishing and in prosecuting a comprehensive state program of pollution abatement and control.

The board has adopted a program of control which maintains a constant

*Taken in part from "Three Rivers Watershed District - Interim Plan" prepared by Burgess and Niple, Columbus, Ohio and Havens and Emerson, Cleveland, Ohio.

review and steady pressure for pollution abatement. Subject to limitations and conditions imposed by the board to protect the receiving streams, municipalities, industries, and other entities may discharge effluents into waters of the state. Failure, after formal hearings and board orders, to meet the limitations and conditions can result in litigation leading to fines and imprisonment.

All such entities are required to secure permits from the Water Pollution Control Board, even including those which have installed approved sewage and waste treatment facilities. The formal discharge permit itself is general in nature, being specific only as to expiration date but subject to certain conditions. The key to the permit is the accompanying letter which states specifically the conditions which must be met during the permit period if the permit is to be renewed. When renewal applications are received, the staff reviews the information to determine whether the conditions have been met. If so, a new permit is issued with an accompanying letter stating the conditions which must be met for future renewal.

The board may issue a short permit of three months minimum, calling merely for the hiring of engineers. Succeeding permits would allow reasonable time periods for subsequent steps, such as the preparation of general plans, preparation of detail plans, financing, and various stages of construction. This program affords the board a constant review of progress being made.

Cases are brought before the board only when an applicant for permit renewal has failed to comply with the conditions during the previous permit period. Even in these cases, new permits may be issued if adequate reasons for non-compliance are supplied with the application and if adequate assurance is given that satisfactory progress can be made in the future. When the Water Pollution Control Board is not satisfied with the written explanations an order may be issued for the applicant to appear before the board and "show cause" why the

application for the permit should not be denied. If the board should issue a permit after a show cause hearing, the renewal conditions for that permit then take on the nature of a specific board order.

If the board, after a show cause hearing, should decide not to issue a permit, its next step is to issue a "violation order." Under this order, the alleged violator is entitled to another hearing after which the board may make a "finding" of violation, issue a "cease and desist" order, and call upon the Attorney General to begin a prosecution of the case in the courts. Conviction can lead to fines up to $500 a day and possible imprisonment up to a year, or both. In addition, any person convicted of violating such sections may also be enjoined "from continuing such violation".

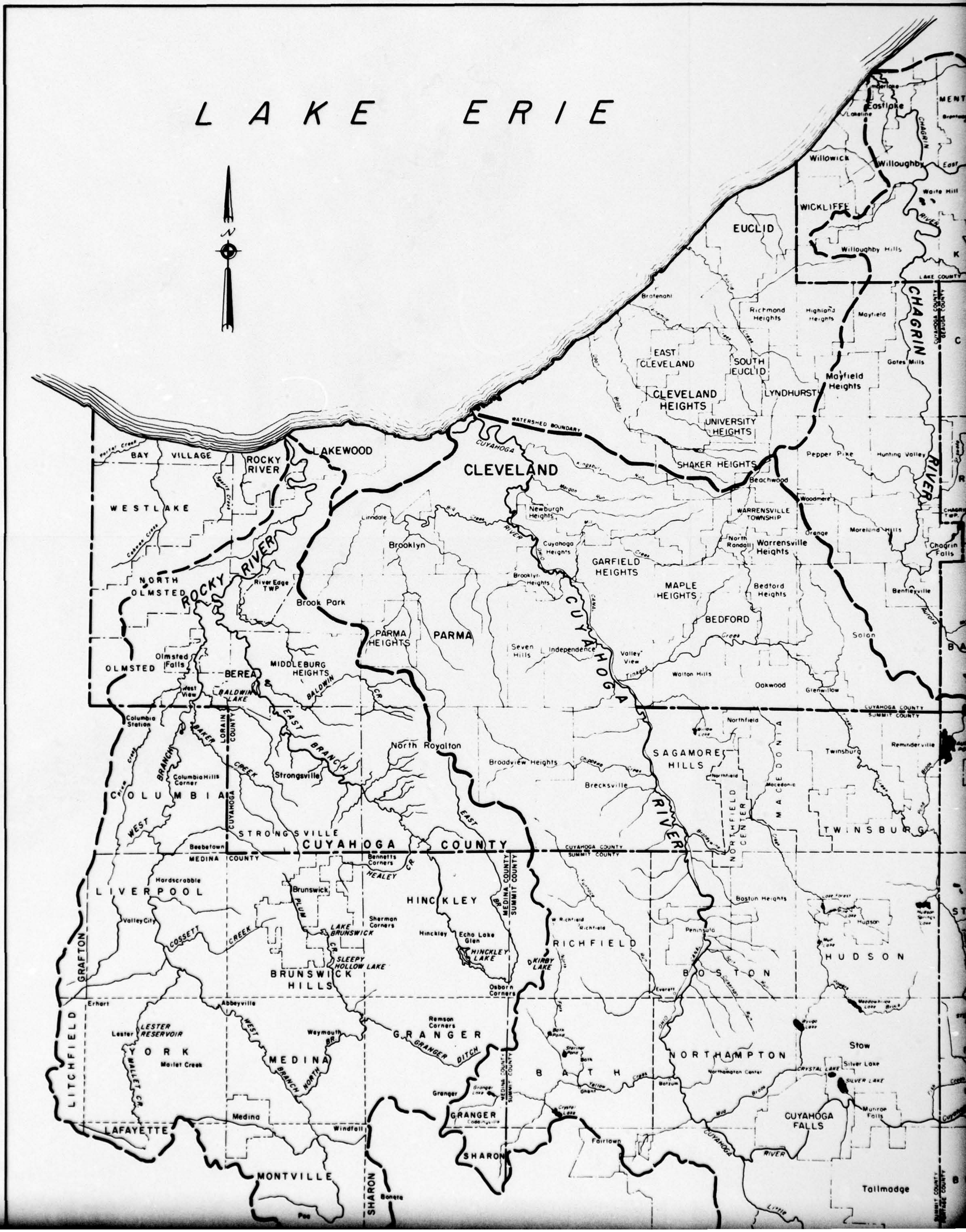
The permit system is regarded by the Ohio Department of Health as highly satisfactory because it is a mechanism by which pollution and its solution become the joint concern of the department and the permittee. Generally excellent working relations and cooperation are sustained through the requirement that the permittee propose the solution, subject to review and approval by the department. Arbitrary treatment requirements are not imposed. This element of "working together" is considered to be extremely important to the prosecution of the pollution abatement program. As a continuing procedural tool, the permit system is also a method of surveillance which, in effect, protects the waters of the state by making illegal any discharges that do not meet certain standards of quality.

III

THE STUDY AREA IN THE FUTURE

APPENDIX I

1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Highland Heights
Mayfield
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SOUTH EUCLID
CLEVELAND HEIGHTS
LYNDHURST
Mayfield Heights
Gates Mills
UNIVERSITY HEIGHTS
WATERSHED BOUNDARY
SHAKER HEIGHTS
Pepper Pike
Hunting Valley
Beachwood
CHAGRIN RIVER
LAKE COUNTY
CUYAHOGA COUNTY
BAY VILLAGE
ROCKY RIVER
LAKEWOOD
CLEVELAND
CUYAHOGA
WESTLAKE
Linndale
Brooklyn
Newburgh Heights
Woodmere
WARRENSVILLE TOWNSHIP
Orange
Moreland Hills
Chagrin Falls
Cuyahoga Heights
North Randall
Warrensville Heights
GARFIELD HEIGHTS
NORTH OLMSTED
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River Edge TWP
Brook Park
Brooklyn Heights
MAPLE HEIGHTS
Bedford Heights
Bentleyville
BEDFORD
PARMA HEIGHTS
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Seven Hills
Independence
Valley View
Solon
OLMSTED
Olmsted Falls
BEREA
MIDDLEBURG HEIGHTS
Walton Hills
Oakwood
Glenwillow
West View
BALDWIN LAKE
CUYAHOGA COUNTY
SUMMIT COUNTY
Columbia Station
LORAIN COUNTY
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Columbia Hills Corner
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Broadview Heights
Brecksville
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CUYAHOGA COUNTY
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STRONGSVILLE
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Bennetts Corners
HEALEY CR
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Brunswick
HINCKLEY
MEDINA COUNTY
SUMMIT COUNTY
Boston Heights
Valley City
Sherman Corners
LAKE BRUNSWICK
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Peninsula
Hudson
GRAFTON
COSSETT CREEK
Hinckley
Echo Lake Glen
HINCKLEY LAKE
SLEEPY HOLLOW LAKE
KIRBY LAKE
RICHFIELD
HUDSON
BRUNSWICK HILLS
BOSTON
Osborn Corners
Everett
Erhart
Abbeyville
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LESTER RESERVOIR
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Mallet Creek
GRANGER DITCH
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SILVER LAKE
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MALLET CR
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Botzum
Ghent
CUYAHOGA FALLS
Munroe Falls
Medina
GRANGER
LAFAYETTE
Windfall
Fairlawn
CUYAHOGA RIVER
SHARON
MONTVILLE
SHARON
Tallmadge
SUMMIT COUNTY
PORTAGE COUNTY

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MENTOR
Brentwood
Eastlake
Lakeline
CHAGRIN
Willoughby
Kirtland Hills
East Branch
Kirtland
Waite Hill
RIVER
HOLDEN ARBORETUM
CHAPIN STATE FOREST
CHARDON
Chardon
Willoughby Hills
KIRTLAND
Hambden
HAMBDEN
MONTVILLE
LAKE COUNTY
Mayfield
CHAGRIN
West Bass Lake
BASS LAKE
Aquilla
LAKE AQUILLA
HUNTSBURG
CHESTER
MUNSON
CLARIDON
Chester Center
Chesterland
Gates Mills
Fowlers Mill
Claridon
East Claridon
EAST BRANCH RESERVOIR
Mayfield Heights
Novelty
Fullertown
Burton Stat
Hunting Valley
RIVER
NEWBURY
Burton
MIDDLEFIELD
Middlefield
RUSSELL
Kiwanis Lake
Russell Center
Newbury Center
PUNDERSON LAKE
BURTON
CHAGRIN FALLS TWP
Moreland Hills
Chagrin Falls
South Russell
Burton Lake
WATERSHED BOUNDARY
Bentleyville
Lake Lucerne
AUBURN
TROY
Bainbridge
Auburn Corners
Auburn Center
LA DUE RESERVOIR
Welshfield
Solon
BAINBRIDGE
Taborville
GEAUGA LAKE
GEAUGA COUNTY
PORTAGE COUNTY
CUYAHOGA COUNTY
AURORA
AURORA POND
Hiram Rapids
HIRAM
MANTUA
Aurora
Mantua Corners
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Cuyahoga
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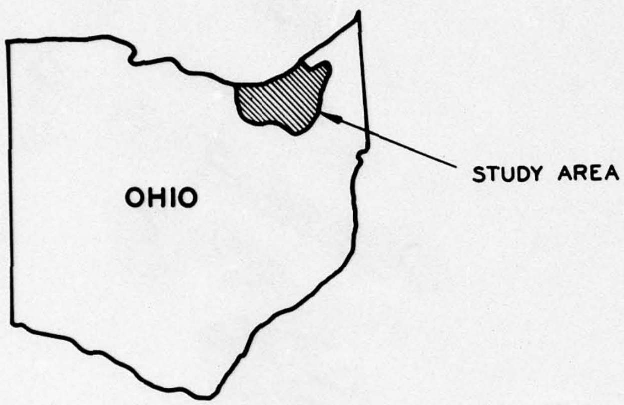
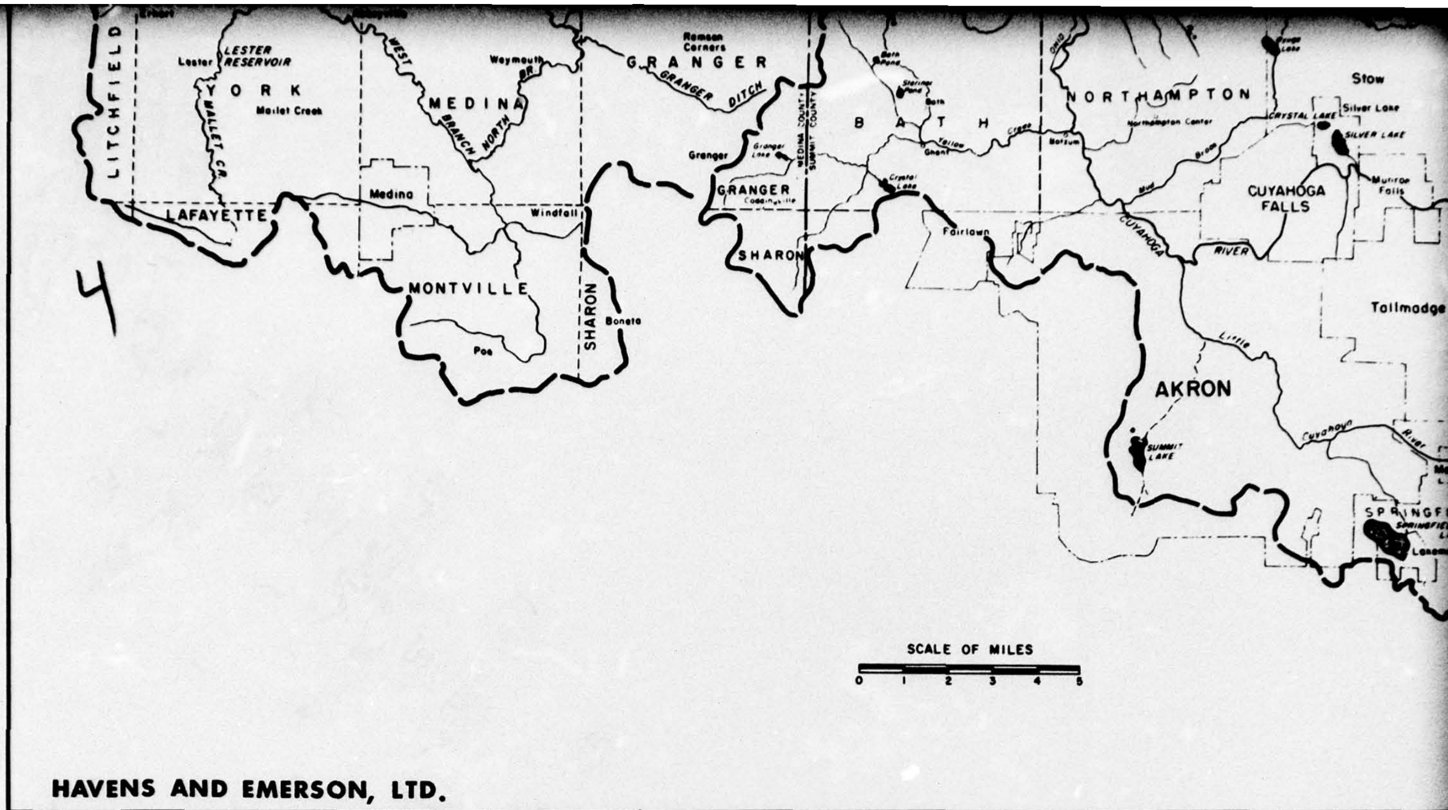
STREETSBORO
SHALERSVILLE
Shalersville
RAVENNA
OHIO

3

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GRANGER DITCH
BATH
NORTHAMPTON
Northampton Center
Stow
Silver Lake
SILVER LAKE
CRYSTAL LAKE
CUYAHOGA FALLS
Munroe Falls
Granger
GRANGER
Medina
Windfall
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MONTVILLE
SHARON
Poe
Boneta
Fairlawn
CUYAHOGA RIVER
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SUMMIT LAKE
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SCALE OF MILES
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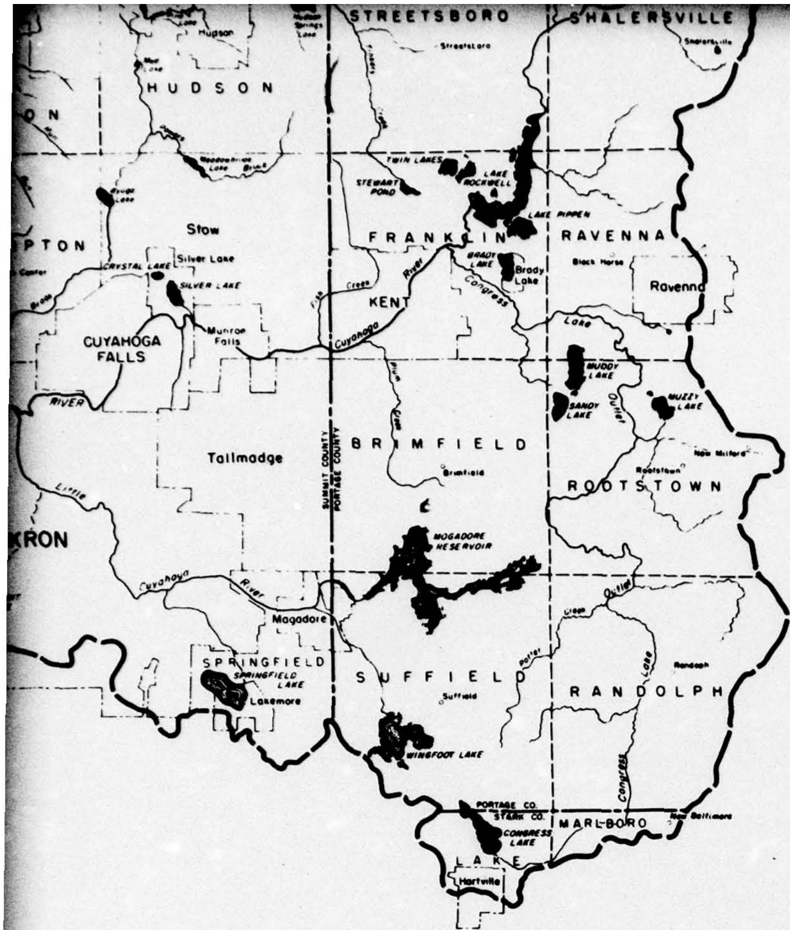
HAVENS AND EMERSON, LTD.



FEA

WASTEWATER

5

FIG. II-1

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT PROGRAM

THE STUDY AREA

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LAKE ERIE
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Eastlake
Willowick
Willoughby
Waite Hill
WICKLIFFE
Willoughby Hills
CHAGRIN RIVER
LAKE COUNTY
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Bratenahl
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Highland Heights
Mayfield
EAST CLEVELAND
SOUTH EUCLID
Gates Mills
CLEVELAND HEIGHTS
LYNDHURST
Mayfield Heights
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UNIVERSITY HEIGHTS
97
WATERSHED BOUNDARY
CUYAHOGA
Pepper Pike
Hunting Valley
SHAKER HEIGHTS
Beachwood
BAY VILLAGE
ROCKY RIVER
LAKEWOOD
CLEVELAND
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Orange
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Linndale
Brooklyn
Cuyahoga Heights
GARFIELD HEIGHTS
North Randall
Warrensville Heights
Chagrin Falls
NORTH OLMSTED
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River Edge TWP
Brook Park
Brooklyn Heights
MAPLE HEIGHTS
Bedford Heights
Bentleyville
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PARMA HEIGHTS
PARMA
CUYAHOGA
BEDFORD
Solon
Olmsted Falls
MIDDLEBURG HEIGHTS
Seven Hills
Independence
Valley View
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BEREA
BALDWIN
Walton Hills
Oakwood
Glenwillow
West View
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CUYAHOGA COUNTY
SUMMIT COUNTY
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North Royalton
Northfield
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Twinsburg
Reminderville
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LORAIN COUNTY
Broadview Heights
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Columbia Hills Corner
Strongsville
Brecksville
Macedonia
COLUMBIA
WEST BRANCH
MACEDONIA
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TWINSBURG
STRONGSVILLE
CUYAHOGA COUNTY
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RIVER
Beebetown
MEDINA COUNTY
Bennetts Corners
HEALEY CR.
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Hardscrabble
LIVERPOOL
PROPOSED
Brunswick
HINCKLEY
MEDINA COUNTY
SUMMIT COUNTY
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Valley City
Sherman Corners
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Echo Lake Glen
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Peninsula
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COSSETT CREEK
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KIRBY LAKE
HUDSON
BRUNSWICK HILLS
BOSTON
Osborn Corners
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Erhart
Abbeyville
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Remsen Corners
Weymouth
GRANGER
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Silver Lake
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SILVER LAKE
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SHARON
Fairlawn
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MONTVILLE
SHARON
Tallmadge

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CHAGRIN STATE FOREST
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MUZZY LAKE
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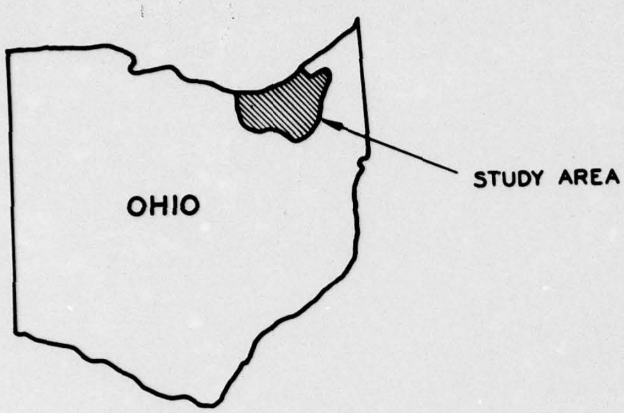
WATERSHED BOUNDARY
OHIO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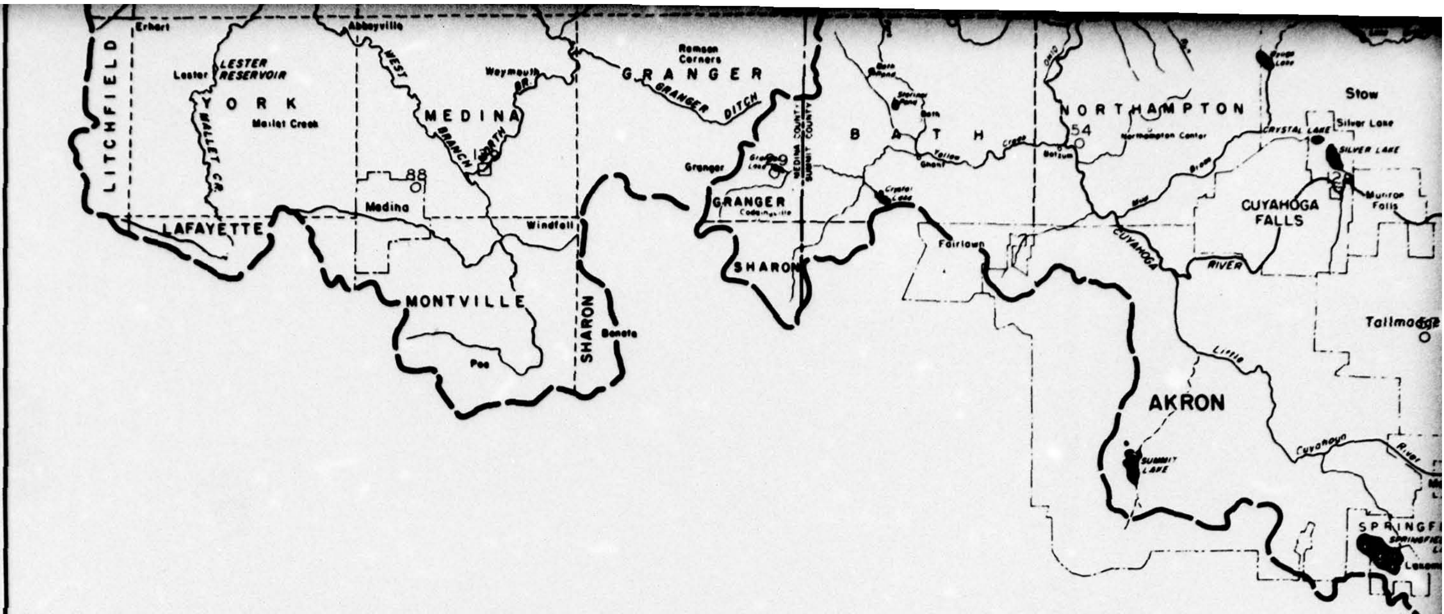

4

○ 84 – MUNICIPAL WASTEWATER TREATMENT PLANT AS SHOWN ON TABLE II - 8.

□ 136 – WATER TREATMENT PLANT AS SHOWN ON TABLE II - 9.

SCALE OF MILES

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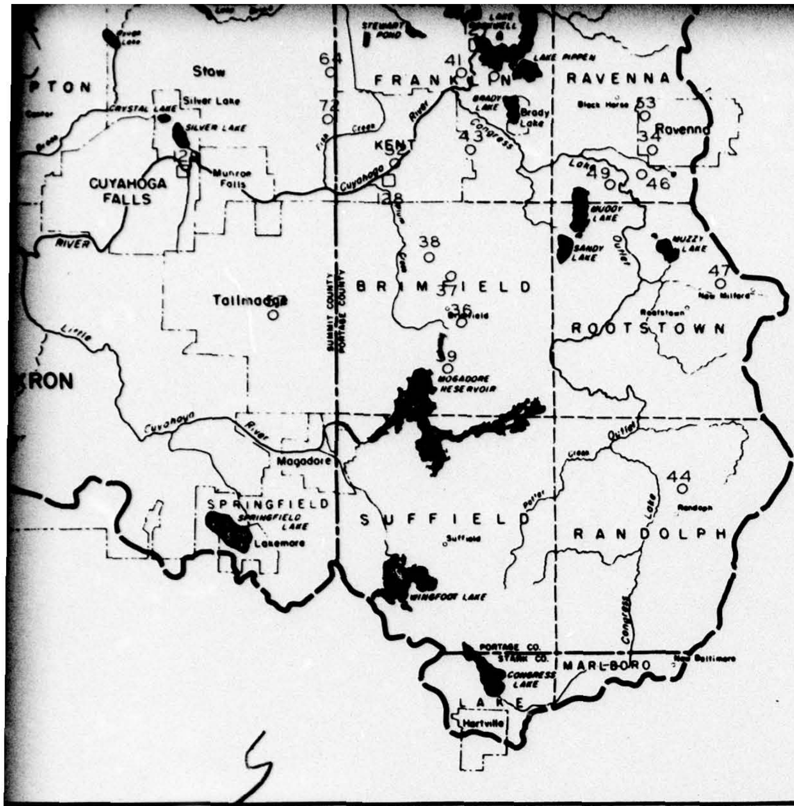

FE

WASTEWATE

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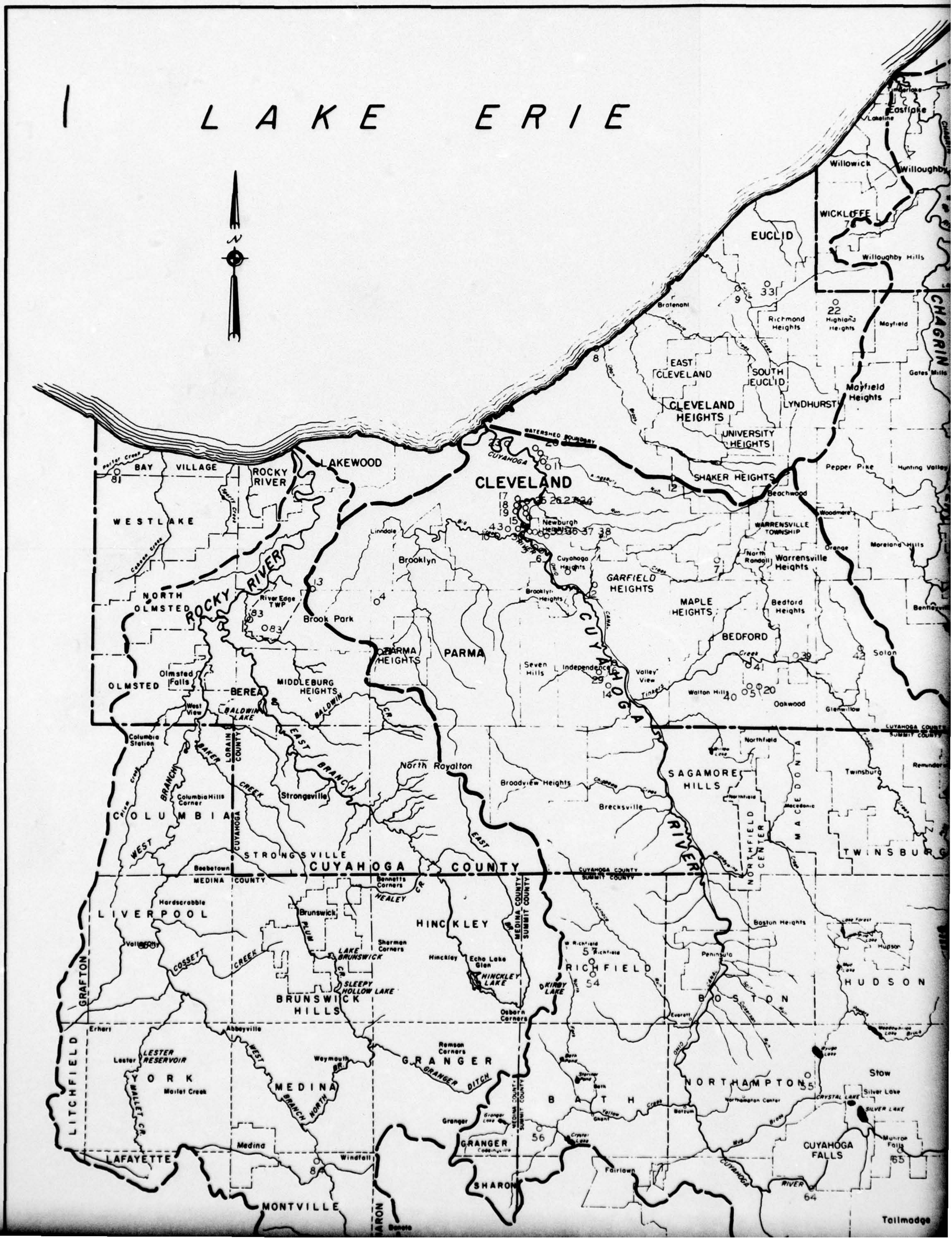
FIG. II-2

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT PROGRAM

MUNICIPAL DISCHARGES

6



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SILVER LAKE
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LAFAYETTE
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SHARON
MONTVILLE
Tallmadge
CUYAHOGA RIVER

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Kirtland Hills
HOLDEN ARBORETUM
CHAPIN STATE FOREST
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CHARDON
Chardon
HAMBDEN
MONTVILLE
LAKE COUNTY
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RIVER
Highland Heights
Mayfield
CHESTER
MUNSON
CLARIDON
HUNTSBURG
BASS LAKE
LAKE AQUILLA
EAST BRANCH RESERVOIR
Gates Mills
Mayfield Heights
Pepper Pike
Hunting Valley
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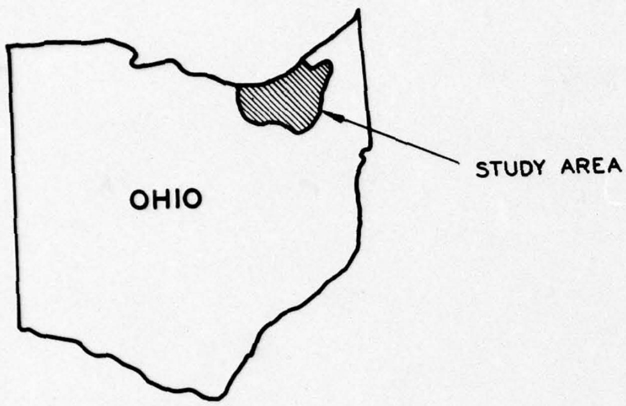

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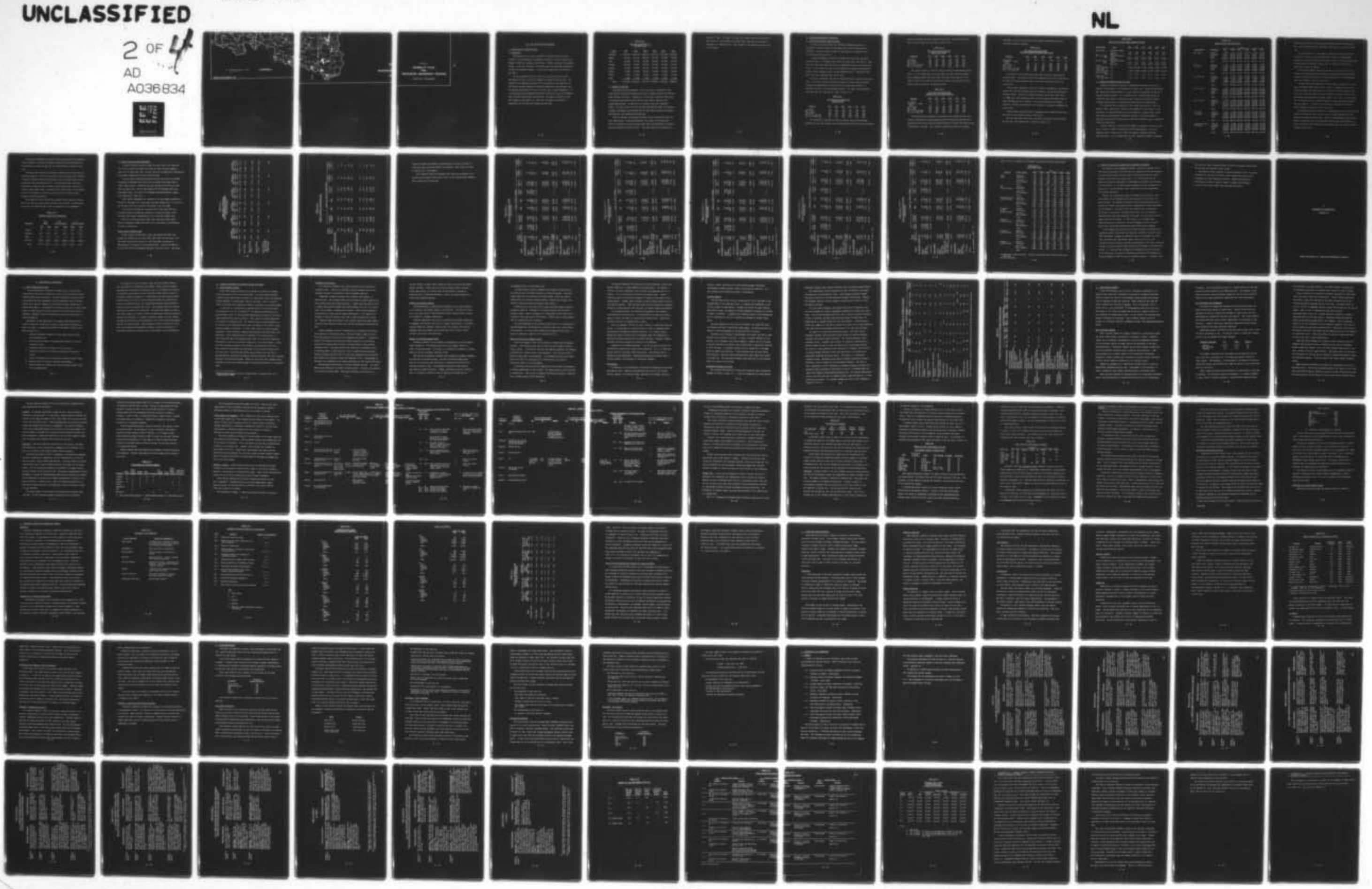

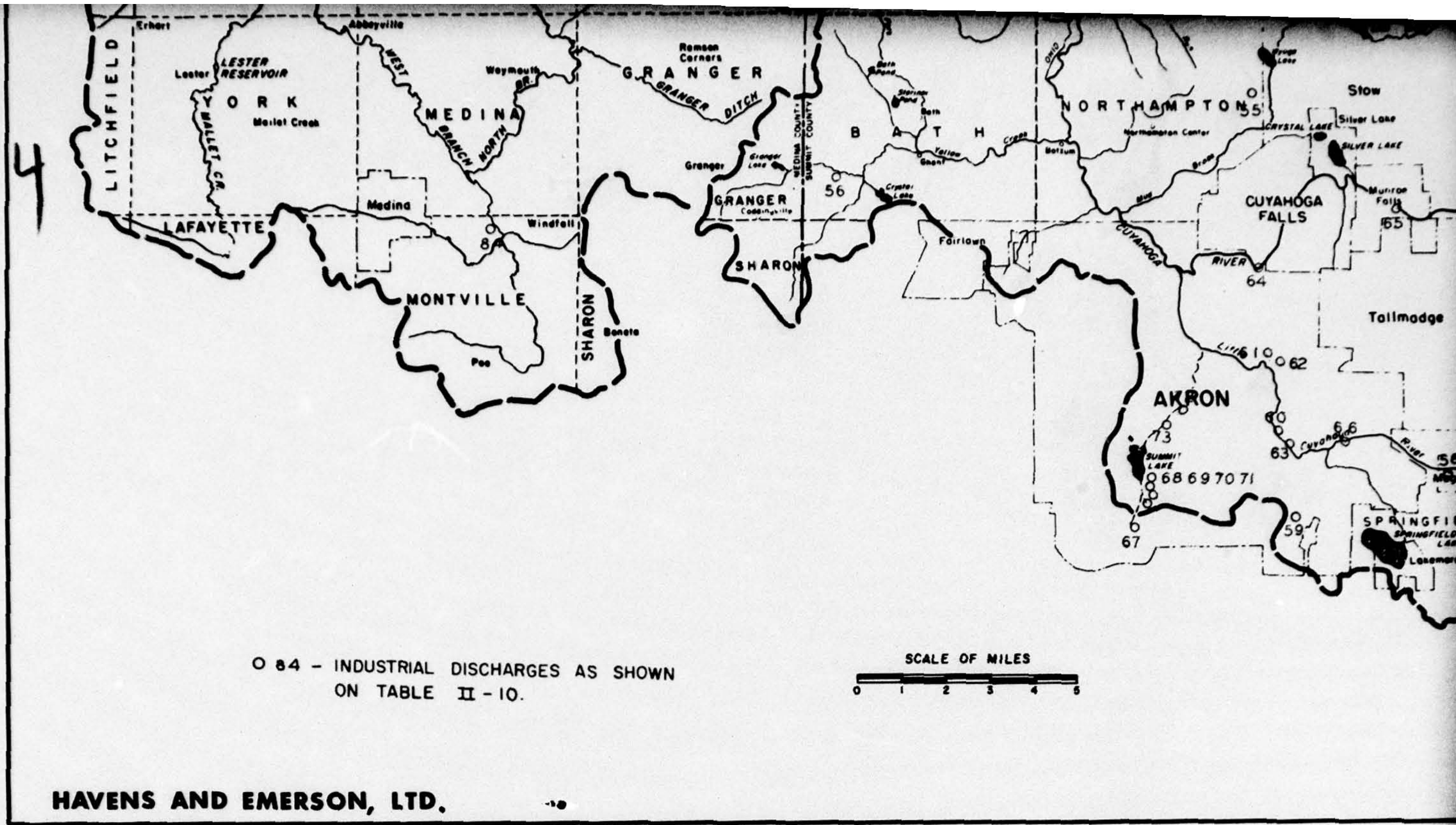
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Weymouth
Medina
Windfall
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MONTVILLE
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GRANGER DITCH
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Granger Lake
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MEDINA COUNTY
SUMMIT COUNTY
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Crystal Lake
Fairlawn
NORTHAMPTON
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Northampton Center
Botzum
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Silver Lake
SILVER LAKE
CRYSTAL LAKE
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SPRINGFIELD LAKE
Lakemore
O 84 - INDUSTRIAL DISCHARGES AS SHOWN
ON TABLE II - 10.
SCALE OF MILES
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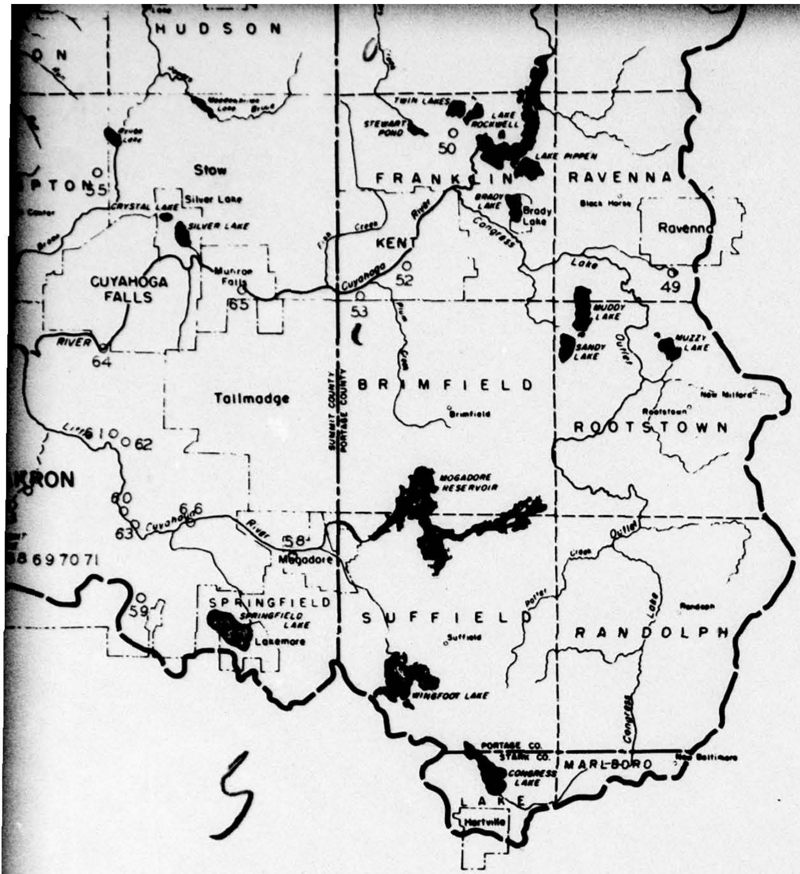
HAVENS AND EMERSON, LTD.



FE

WASTEWATE

IND

FIG II-3

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT PROGRAM

INDUSTRIAL DISCHARGES

6

III - THE STUDY AREA IN THE FUTURE

A. DESCRIPTION OF PROBABLE GROWTH

1. POPULATION

Populations are not usually projected for periods beyond 25 years because of the uncertainties of migration, changes in birth and death rates, changes in land use, and many other factors. Usually, accuracy of projection improves as the size increases, since small areas are much more susceptible to local environmental changes. In this case, projections are desired to year 2020.

The total population of the study area is projected to grow from a 1970 figure of about 2,421,000 to roughly 4,157,000 by the year 2020. The majority of the population growth will be the result of the expansion of the ring of suburban communities centering around Akron and Cleveland, and the gradual consolidation of these two cities into a single megalopolis. It is anticipated that considerable population growth will occur in the Medina area, the area between Akron and Cleveland, and around the smaller cities and villages in the study area. Table III-1 presents the projected populations of the study area through the year 2020.

TABLE III-1

PROJECTED POPULATIONS OF THE STUDY AREA

County	1970	1980	1990	2000	2010	2020
Cuyahoga	1,632,700	1,836,100	2,090,500	2,285,300	2,392,800	2,385,600
Summit	466,300	531,700	604,500	667,600	714,800	740,200
Lake	108,700	151,400	206,600	259,900	307,000	337,200
Portage	101,600	141,900	186,700	231,200	276,700	314,600
Geauga	56,900	78,600	105,700	131,700	163,500	195,200
Medina	44,800	65,100	88,800	110,600	129,600	145,500
Lorain	8,100	14,800	27,300	31,200	32,800	34,500
Stark	1,900	2,400	2,900	3,300	3,500	3,600
TOTAL	2,421,000	2,822,000	3,313,000	3,720,800	4,020,700	4,156,400

2. CHANGES IN LAND USE

The majority of the population in the study area is contained in the urban centers of Akron and Cleveland and their suburban rings of the influence zones of these two cities. Populations will increase within these two rings by increasing the density within built-up areas and by filling in the undeveloped property. Zoning will be a critical issue and a dependent factor. The outer ring in the zone between Cleveland and Akron will probably disappear altogether except perhaps for the area around Richfield, Peninsula, Reminderville, and southwestern Streetsboro.

Land use patterns are expected to remain fairly stable during the fifty year study period. Increased populations will result by increasing the density of population within existing urban areas and development of sparsely populated suburban residential areas. Cultivated lands can be expected to

decrease in area. The number of farms will probably continue to decline as small farms are consolidated into larger farms, and land is converted to residential or commercial use. Some increase in recreational and park land is anticipated.

B. WASTEWATER MANAGEMENT PROJECTIONS

1. PROJECTED MUNICIPAL FLOWS AND LOADS

In order to plan rationally for wastewater management purposes, a reasonably accurate inventory of projected waste loads and flows must be developed. Municipal wastes account for the majority of wastewater flow to be treated and disposed of.

A computer program was written to estimate the waste flows and waste loads arriving at a treatment plant during the fifty year study period. Flows and waste loads were predicted based on estimated per capita waste generation rates. The only required input to the program was the predicted populations served by each treatment plant or waste collection point. Projections were made at ten year intervals from 1970 to 2020.

Four basic approaches were used in estimating future wastewater generation rates. The first concept considered was based on current water use trends, assuming that approximately fifteen percent of those homes served by a sewerage system will use home garbage grinders. Per capita waste generation rates for this first approach are shown in Table III-2.

TABLE III-2

PER CAPITA LOAD PROJECTIONS
CURRENT TRENDS

Quantity	1970	1980	1990	2000	2010	2020
Q in gpcd	110	120	125	130	140	150
BOD in mg/l	185	180	178	174	163	155
SS in mg/l	185	170	165	160	155	150
BOD in lb./cap./day	.170	.180	.185	.190	.190	.195
SS in lb./cap./day	.170	.171	.172	.174	.180	.187

The second basic approach was based on current usage of home garbage grinders but with the increased use of modified sanitary facilities and plumbing

systems to minimize the waste volume from the home. The waste generation rates for this second case are shown in Table III-3.

TABLE III-3

PER CAPITA LOAD PROJECTIONS
REDUCED FLOW TREND

Quantity	1970	1980	1990	2000	2010	2020
Q in gpcd	110	113	110	105	107	107
BOD in mg/l	185	191	202	217	213	218
SS in mg/l	185	180	187	198	202	210
BOD in lb./cap./day	.170	.180	.185	.190	.190	.195
SS in lb./cap.day	.170	.170	.172	.174	.180	.187

The third estimate involved the increased usage of home garbage grinder units. It was assumed that by the year 2000, all homes would be equipped with a garbage grinder unit which would discharge to the municipal sewer system. Table III-4 shows the estimated per capita waste generation rates based on the increased use of garbage grinders.

TABLE III-4

PER CAPITA LOAD PROJECTIONS
INCREASED USE OF GARBAGE GRINDING

Quantity	1970	1980	1990	2000	2010	2020
Q in gpcd	110	120	126	133	143	153
Grinders % - Homes Using	15	25	40	100	100	100
BOD in mg/l	185	202	209	246	232	229
SS in mg/l	185	185	192	238	226	217
BOD in lb./cap./day	.170	.202	.220	.273	.277	.292
SS in lb./cap./day	.170	.185	.202	.264	.270	.277

The fourth and last approach to estimating waste generation rates was based on increased use of home garbage grinders along with increased use of modified sanitary facilities and plumbing systems to minimize the waste stream originating in the home. This results in the lowest volume but strongest

wastewater. Table III-5 presents the per capita waste generation rates developed using this approach.

TABLE III-5

PER CAPITA LOAD PROJECTIONS
INCREASED GARBAGE GRINDING REDUCED FLOW

Quantity	1970	1980	1990	2000	2010	2020
Q in gpcd	110	113	111	108	110	110
Grinders % - Homes Using	15	24	40	100	100	100
BOD in mg/l	185	214	238	303	302	318
SS in mg/l	185	196	218	293	294	302
BOD in lbs./cap./day	.170	.202	.220	.273	.277	.292
SS in lbs./cap./day	.170	.185	.202	.264	.270	.277

The results of these four basic projections provide a range of waste loads and flows. The results of the first approach (Table III-1) were used as the final per capita generation rates since these values were felt to be conservative.

The per capita generation rates for nitrogen and phosphates were based on monthly data from the Cleveland Easterly, Southerly, and Westerly Wastewater Treatment Plants. Results of studies at Chanute, Kansas (Ref. JWPCF 30:1, 1 & JAWWA 50:8, 1022) formed the basis of the per capita generation rates of total chlorides and total sulfates. The rate of production of sulfates, chlorides, nitrogen and phosphates were assumed to be constant throughout the study period.

The per capita generation rates of municipal waste loads and flows that were used in this study are shown in Table III-6.

The total municipal waste loads and flows are shown for each watershed for the years 1970 through 2020, by decade in Table III-7.

TABLE III-6

MUNICIPAL PER CAPITA WASTE GENERATION RATES

Constituent	Area	1970	1980	1990	2000	2010	2020
Flow (gpcd)	Combined Sewered Area	156	160	164	168	172	175
	New Area	110	120	125	130	140	150
BOD (lb./cap./day)	Combined Sewered Area	0.15	0.15	0.16	0.16	0.17	0.17
	New Area	0.17	0.18	0.185	0.19	0.19	0.195
SS (lb./cap./day)	Combined Sewered Area	0.23	0.23	0.24	0.24	0.25	0.25
	New Area	0.17	0.17	0.172	0.174	0.180	0.187
Total N (lb./cap./day)	All	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243
PO_4 as PO_4 (lb./cap./day)	All	0.0354	0.0354	0.0354	0.0354	0.0354	0.0354
SO_4 (lb./cap./day)	All	0.16	0.16	0.16	0.16	0.16	0.16
Chlorides (lb./cap./day)	All	0.19	0.19	0.19	0.19	0.19	0.19

2. PROJECTED INDUSTRIAL FLOWS AND LOADS

Industrial wastewaters comprise a significant percentage of the total quantity of wastewaters to be handled in the study area. Industrial wastewaters may contain high concentrations of a large range of contaminants and may pose serious pollution hazards. It is imperative that reasonable projections of industrial waste loads be obtained in order to provide rationally for their treatment and disposal in a satisfactory manner during the study period.

The industrial flows calculated in this report were based on a flow per employee ratio, rather than a flow per unit production ratio, because of the difficulty in relating different units of production to specific flow values. Also, there was considerable information available on both the number of employees and typical flow per employee values for different types of industries within the study area.

The first step was to find the total number of employees within the study area. Using as a source the directory of Ohio Manufacturers, a list was compiled, both by counties and 3 digit SIC numbers (Standard Industrial Classification), of all manufacturers and their respective number of employees

TABLE III-7

DOMESTIC WASTE LOAD PROJECTIONS

Constituent	Watershed	Year 1970	1980	1990	2000	2010	2020
Flow (mgd)	Chagrin	2.64	4.44	6.88	8.84	11.90	15.00
	Cuyahoga	158.73	209.20	260.58	297.66	335.46	363.63
	Rocky	32.80	32.44	30.50	35.43	40.50	44.48
	Lake	143.52	164.32	194.50	219.24	238.91	248.68
	Total	337.69	410.40	492.46	561.17	626.77	671.79
Total N (lb./day)	Chagrin	600	900	1,300	1,700	2,100	2,400
	Cuyahoga	25,300	33,700	41,500	46,300	50,500	53,300
	Rocky	6,000	5,200	4,500	5,200	5,800	6,300
	Lake	22,400	25,000	28,800	31,700	33,800	34,500
	Total	54,300	64,800	76,100	84,900	92,200	96,500
PO_4 (lb./day)	Chagrin	800	1,300	1,900	2,400	3,000	3,500
	Cuyahoga	36,900	49,100	60,500	67,400	73,600	77,600
	Rocky	8,800	7,500	6,600	7,500	8,500	9,200
	Lake	32,600	36,400	42,000	46,200	49,200	50,300
	Total	79,100	94,300	111,000	123,500	134,300	140,600
BOD (lb./day)	Chagrin	4,100	6,700	10,200	12,900	16,200	19,500
	Cuyahoga	158,000	217,500	285,800	322,500	367,500	391,600
	Rocky	39,800	33,700	29,800	34,100	41,000	44,900
	Lake	138,000	154,100	189,800	208,800	236,100	241,600
	Total	339,900	412,000	515,600	578,300	660,800	697,600
SO_4 (lb./day)	Chagrin	3,800	5,900	8,800	10,900	13,600	16,000
	Cuyahoga	166,700	221,900	273,300	304,800	332,800	350,700
	Rocky	39,700	34,100	29,800	33,900	38,200	41,400
	Lake	147,200	164,300	189,700	208,800	222,200	227,400
	Total	357,400	426,200	501,600	558,400	606,800	635,500
Chlorides (lb./day)	Chagrin	4,600	7,000	10,500	12,900	16,200	19,000
	Cuyahoga	198,000	263,500	324,500	362,000	395,200	416,500
	Rocky	47,100	40,500	35,300	40,200	45,400	49,200
	Lake	174,800	195,100	225,300	248,000	264,000	270,000
	Total	424,500	506,100	595,600	663,100	720,800	754,700
Suspended Solids (lb./day)	Chagrin	4,100	6,300	9,500	11,800	15,300	18,700
	Cuyahoga	234,600	300,000	375,900	418,300	471,300	497,700
	Rocky	49,400	45,400	44,600	50,600	58,400	62,700
	Lake	211,600	236,200	284,600	313,200	347,300	355,300
	Total	499,700	587,900	714,600	793,900	892,300	934,400

within the study area. By checking the addresses of these manufacturers, this list was subdivided into individual sewer districts within the study area.

The second step was to determine the employment growth through the year 2020. Using as a source Northeast Ohio Economic and Demographic Projections by Battelle Memorial Institute, a series of projected employment increase ratios (by decades through 2020) was compiled, again both by county and 2 digit SIC numbers.

Utilizing the present employment figures and the projection ratios, a complete list containing both the number of employees and their respective 3 digit SIC numbers, projected by decades through 2020, was developed for each sewer district within the study area.

The next step was to determine an average flow per employee for each 3 digit SIC number using Dalton, Dalton & Little's Industrial Waste Survey Technical Report, for Cleveland, Ohio, together with other available data. A list of 4 digit SIC numbers and their respective average wastewater flow per employee was compiled for Cuyahoga County. This list was consolidated into the needed list of 3 digit SIC numbers and their respective average flow per employee. A survey of the available literature was also made which enabled filling of many of the data gaps.

An assumption that the industries in Cuyahoga County were typical of all industries within the study area was used to estimate average flows per employee throughout the study area. Also, the determination that increased usage of industrial waste as recirculated cooling water would offset any future increase in the average flow per employee kept these values constant through the year 2020.

Grouping the employment projections with the average flow per employee values according to 3 digit SIC numbers, allowed the final calculation of an average daily industrial flow for each sewer district within the study area.

Industrial water demand and wastewater production were broken into the following categories: total water consumed, water lost during use, sanitary discharge, and total industrial discharge, which was further broken down to contaminated and uncontaminated flows. The industrial waste loads were calculated in pounds per day of chemical oxygen demand (COD, five-day bio-chemical oxygen demand (BOD), suspended solids, total solids, total volatile solids, oil and grease, chlorides, sulfates, phenols, nitrates, total nitrogen, and total phosphates.

Total industrial flows and BOD and suspended solids loads are shown in Table III-8 for each watershed for the years 1970 and 2020. More detailed projections of industrial waste loads are presented in the Attachment 1.

TABLE III-8

INDUSTRIAL WASTE LOAD PROJECTIONS

Watershed	Flow (MGD)		BOD (1,000 lb./day)		SS (1,000 lb./day)	
	1970	2020	1970	2020	1970	2020
Chagrin	2.5	5.0	10.	11.7	25.3	24.5
Cuyahoga	44.8	48.9	102.7	124.0	79.4	96.5
Rocky	4.0	3.3	5.8	5.8	3.0	3.4
Lake Erie	39.5	47.9	92.7	122.9	67.7	91.8
TOTAL	90.8	105.1	211.2	264.4	175.4	216.2

3. FUTURE POLLUTION LOADS FROM RUNOFF

In order to project pollution loads for future years, the conditions for the year 2020 were estimated and loads for that year were computed. Loads for the years 1980, 1990, 2000 and 2010 were arithmetically interpolated from figures computed for the years 1970 and 2020.

The major factor affecting conditions for the year 2020 is the higher percentage of developed areas which will cause more storm runoff due to higher imperviousness. Developed areas for various uses in the year 2020 were available from a land use map prepared for the Northeast Ohio Water Development Study. The result of development and imperviousness changes were summarized in Table III-9.

Storm runoff hydrographs were computed in the same manner described in Section II, and Table III-9 shows peak ratio and volumes for 1, 5, 10, 25, 50 and 100-Year storms for conditions prevailing in the year 2020.

Since pollution parameters concentrations for the year 1970 were evaluated without including any municipal or industrial wastes, it was concluded that present concentrations will be valid for future years.

Table III-10 shows pollution loads from 1-Year and 5-Year storms based on hydrograph volumes from Table III-9, and pollution concentrations as stated in Section II.

Future Annual Pollution Loads

Annual volume of stream flows, urban storm runoff and rural storm runoff were computed for the years 1980, 1990, 2000, 2010 and 2020 by the same method described in Section II, but using higher percentage of imperviousness to account for new developed areas. Pollution parameters for the year 1970 were considered applicable for future years. From annual

TABLE III-9

STORM RUNOFF HYDROGRAPHS
SHOWING PEAK RATE AND VOLUMES
FOR THE YEAR 2020

	1-Year		5-Year		10-Year		25-Year		50-Year		100-Year	
	Peak Rate cfs	Volume Million c.f.	Peak Rate cfs	Volume Million c.f.	Peak Rate cfs	Volume Million c.f.	Peak Rate cfs	Volume Million c.f.	Peak Rate cfs	Volume Million c.f.	Peak Rate cfs	Volume Million c.f.
Chagrin River	6,210	325	14,500	700	17,780	900	22,500	1,200	25,340	1,335	30,000	1,475
Rocky River	5,090	440	10,000	900	12,720	1,100	16,000	1,420	18,090	1,575	22,000	1,720
Upper Cuyahoga River	2,380	493	5,250	1,100	6,600	1,366	8,250	1,680	9,780	2,025	12,250	2,550
Lower Cuyahoga River	4,900	631	10,000	1,270	12,140	1,564	14,700	1,850	17,140	2,210	22,000	2,860
East Cleveland, West Cleveland and West Cuyahoga County	-	240	-	473	-	547	-	682	-	740	-	963

TABLE III-10

RUNOFF POLLUTION LOAD PROJECTIONS

Basin	Volume Million C.F.	Loads in 1,000 lb./Storm Event Suspended Solids	BOD	COD	Chloride Cl	Total Nitrogen N	Total Phosphate P
1-Year Storm (Year 2020)							
Chagrin	325	4,058	61	203	1,218	40	4
Rocky	440	5,493	82	274	1,647	54	5.5
Cuyahoga	1,124	14,033	210	702	4,209	139	14
Misc. Areas	240	2,996	45	150	899	30	3
SUB-TOTAL	2,129	26,580	398	1,329	7,973	263	26.5
5-Year Storm (Year 2020)							
Chagrin	700	8,739	131	437	2,621	87	9
Rocky	900	11,237	168	562	3,371	111	11
Cuyahoga	2,370	29,589	443	1,479	8,875	294	30
Misc. Areas	473	5,905	88	295	1,772	58	6
TOTAL	4,443	55,480	830	2,773	16,639	550	56

volume of runoff and contaminant concentrations as shown in Section II, annual pollution loads from runoff were computed. These loads are shown in tabular form in Attachment 1.

The incremental load from combined sewer areas was considered to be constant for the future fifty years since it is not expected that combined sewer systems will be separated.

TABLE III-11

ANNUAL RUNOFF POLLUTION LOADS
FOR YEAR 1980

		Loads in 1,000 lb./Year							
Basin	Annual Volume (Mill.C.F.)	Total Solids	Suspended Solids	BOD	COD	Sulfate SO_4	Chloride Cl	Total Nitrogen N	Total Phosphate P
Dry Weather Stream Flow									
Chagrin	747	16,376	5,905	93	233	3,031	1,632	37	9
Rocky	114	3,200	319	14	35	462	249	6	2
Cuyahoga	4,793	191,839	7,757	598	1,496	19,449	10,472	239	60
Misc. Area	2,050	81,900	6,266	1,200	7,784	8,320	8,960	490	96
Sub-Total	7,704	293,306	20,247	1,905	9,548	31,262	21,313	772	167
Urban Storm Runoff									
Chagrin	1,402		2,625	1,312	3,063		14,091	271	61
Rocky	2,280		4,270	2,135	4,981		22,915	441	99
Cuyahoga	5,141		9,628	4,814	11,232		51,670	994	224
Misc. Area	1,561		2,923	1,461	3,410		15,689	302	68
Incremental Load from Combined Sewer Areas (1)	included in above		11,630	6,165	20,760		4,464	1,328	1,036
Sub-Total	10,384		31,077	15,888	43,448		108,830	3,337	1,489
Rural Storm Runoff									
Chagrin	1,618		20,201	303	1,010		6,060	202	20
Rocky	1,665		20,788	311	1,039		6,236	207	20
Cuyahoga	4,820		60,179	902	3,008		18,053	601	60
Misc. Area	676		8,440	126	422		2,532	84	8
Sub-Total	8,779		109,609	1,644	5,480		32,882	1,096	109
TOTAL	26,867		160,933	19,437	58,476		163,025	5,205	1,765

(1) See footnote 2, page I - 47

TABLE III-11 (Cont'd.)

ANNUAL RUNOFF POLLUTION LOADS
FOR YEAR 1990

Basin	Annual Volume (Mill.C.F.)	Loads in 1,000 lb./Year: Total Solids	Suspended Solids	BOD	COD	Sulfate SO_4	Chloride Cl	Total Nitrogen N	Total Phosphate P
Dry Weather Stream Flow									
Chagrin	747	16,367	5,905	93	233	3,031	1,632	37	9
Rocky	114	3,200	319	14	35	462	249	6	2
Cuyahoga	4,793	191,839	7,757	598	1,496	19,449	10,472	239	60
Misc. Area	2,050	81,900	6,266	1,200	7,784	8,320	8,960	490	96
Sub-Total	7,704	293,306	20,247	1,905	9,548	31,262	21,313	772	167
Urban Storm Runoff									
Chagrin	1,463		2,739	1,369	3,196		14,704	283	63
Rocky	2,454		4,595	2,297	5,361		24,664	474	107
Cuyahoga	5,529		10,354	5,177	12,080		55,570	1,069	241
Misc. Area	1,644		3,078	1,539	3,592		16,523	318	71
Incremental Load from Combined Sewer Areas (1)	included in above		11,630	6,165	20,760		4,464	1,328	1,036
Sub-Total	11,090		32,399	16,549	44,991		115,926	3,474	1,520
Rural Storm Runoff									
Chagrin	1,609		20,089	301	1,004		6,026	200	20
Rocky	1,636		20,426	306	1,021		6,127	204	20
Cuyahoga	4,753		59,343	890	2,967		17,802	593	59
Misc. Area	663		8,277	124	413		2,483	82	8
Sub-Total	8,661		108,136	1,622	5,406		32,440	1,081	108
TOTAL	27,455		160,782	20,076	59,945		169,679	5,327	1,795

(1) See footnote 2, Page I - 47

TABLE III-11 (Cont'd.)

ANNUAL RUNOFF POLLUTION LOADS FOR YEAR 2000

Basin	Annual Volume (Mill.C.F.)	Loads in 1,000 lb./Year: Total Solids	Suspended Solids	BOD	COD	Sulfate SO_4	Chloride Cl	Total Nitrogen N	Total Phosphate P
Dry Weather Stream Flow									
Chagrin	747	16,367	5,905	93	233	3,031	1,632	37	9
Rocky	114	3,200	319	14	35	462	249	6	2
Cuyahoga	4,793	191,839	7,757	598	1,496	19,449	10,472	239	60
Misc. Area	2,050	81,900	6,266	1,200	7,784	8,320	8,960	490	96
Sub-Total	7,704	293,306	20,247	1,905	9,548	31,262	21,313	772	167
Urban Storm Runoff									
Chagrin	1,525		2,856	1,428	3,332		15,327	295	66
Rocky	2,628		4,921	2,460	5,742		26,413	508	114
Cuyahoga	5,917		11,081	5,540	12,928		59,470	1,145	258
Misc. Area	1,727		3,324	1,617	3,773		17,357	334	75
Incremental Load from Combined Sewer Areas(1)	included in above		11,630	6,165	20,760		4,646	1,328	1,036
Sub-Total	11,797		33,723	17,211	46,535		123,214	3,610	1,551
Rural Storm Runoff									
Chagrin	1,600		19,976	299	998		5,992	199	19
Rocky	1,607		20,064	300	1,003		6,019	200	20
Cuyahoga	4,686		58,506	877	2,925		17,551	585	58
Misc. Area	650		8,116	121	405		2,434	81	8
Sub-Total	8,543		106,662	1,599	5,333		31,998	1,066	106
TOTAL	28,044		160,632	20,715	71,416		176,714	5,448	1,824

(1) See footnote 2, Page I - 47

TABLE III-11 (Cont'd.)

ANNUAL RUNOFF POLLUTION LOADS
FOR YEAR 2010

Basin	Annual Volume (Mill.C.F.)	Loads in 1,000 lb./Year: Total Solids	Suspended Solids	BOD	COD	Sulfate SO_4	Chloride Cl	Total Nitrogen N	Total Phosphate P
Dry Weather Stream Flow									
Chagrin	747	16,367	5,905	93	233	3,031	1,632	37	9
Rocky	114	3,200	319	14	35	462	249	6	2
Cuyahoga	4,793	191,839	7,757	598	1,496	19,449	10,472	239	60
Misc. Area	2,050	81,900	6,266	1,200	7,784	8,320	8,960	490	96
Sub-Total	7,704	293,306	20,247	1,905	9,548	31,262	21,313	772	167
Urban Storm Runoff									
Chagrin	1,586		2,970	1,485	3,465		15,940	306	69
Rocky	2,802		5,247	2,623	6,122		28,162	542	122
Cuyahoga	6,305		11,808	5,904	13,776		63,369	1,220	275
Misc. Area	1,810		3,389	1,694	3,954		18,191	350	79
Incremental Load from Combined Sewer Areas (1)	included in above		11,630	6,165	20,760		4,646	1,328	1,036
Sub-Total	12,503		35,045	17,872	48,078		130,310	3,747	1,582
Rural Storm Runoff									
Chagrin	1,591		19,864	297	933		5,959	198	19
Rocky	1,578		19,701	295	985		5,910	197	19
Cuyahoga	4,619		57,670	865	2,883		17,301	576	57
Misc. Area	637		7,953	119	397		2,385	79	7
Sub-Total	8,425		105,189	1,577	5,259			1,051	105
TOTAL	28,632		160,481	21,354	62,885		183,179	5,570	1,854

(1) See footnote 2, Page I - 47

TABLE III-11 (Cont'd.)

ANNUAL RUNOFF POLLUTION LOADS
FOR YEAR 2020

Basin	Annual Volume (Mill.C.F.)	Total Solids	Suspended Solids	BOD	COD	Sulfate SO_4	Chloride Cl	Total Nitrogen N	Total Phosphate P
		Loads in 1,000 lb./Year							
Dry Weather Stream Flow									
Chagrin	747	16,367	5,905	93	233	3,031	1,632	37	9
Rocky	114	3,200	319	14	35	462	249	6	2
Cuyahoga	4,793	191,839	7,757	598	1,496	19,449	10,472	239	60
Misc. Area	2,050	81,900	6,266	1,200	7,784	8,320	8,960	490	96
Sub-Total	7,704	293,306	20,247	1,905	9,548	31,262	21,313	772	167
Urban Runoff									
Chagrin	1,648		3,085	1,542	3,600		16,564	318	72
Rocky	2,977		5,572	2,786	6,504		29,921	576	130
Cuyahoga	6,694		12,531	6,265	14,626		67,921	1,295	292
Misc. Area	1,894		3,545	1,772	4,138		19,036	366	82
Incremental Load from Combined Sewer Areas (1)	included in above	———	11,630	6,165	20,760	———	4,646	1,328	1,036
Sub-Total	13,213		36,363	18,530	49,628		137,447	3,883	1,612
Rural Runoff									
Chagrin	1,582		19,751	295	987		5,924	196	18
Rocky	1,549		19,339	289	966		5,801	192	18
Cuyahoga	4,552		56,831	851	2,840		17,047	564	54
Misc. Areas	624	———	7,790	116	389	———	2,336	77	7
Sub-Total	8,307		103,711	1,551	5,182		31,108	1,029	97
TOTAL	29,224		160,321	21,986	64,358		189,868	5,684	1,876

(1) See footnote 2, page I - 47

Table III-12 is a summary of the Domestic, Industrial and Basin Runoff Loads.

TABLE III-12
TOTAL WASTE LOADS

Quantity	Waste Source	Year 1970	1980	1990	2000	2010	2020
Flow (MGD)	Domestic	338	410	492	561	627	672
	Industrial	91	91	96	99	102	105
	Sub-Total	429	501	588	660	729	777
	Basin Runoff*	539	551	563	575	587	599
	Total	968	1,052	1,151	1,235	1,316	1,376
BOD (1,000 lb/day)	Domestic	340	412	516	578	661	698
	Industrial	211	221	235	249	259	264
	Sub-Total	551	633	751	827	920	962
	Basin Runoff*	52	53	55	57	59	60
	Total	603	686	806	884	979	1,022
Suspended Solids (1,000 lb/day)	Domestic	500	588	715	794	892	934
	Industrial	176	182	192	202	210	216
	Sub-Total	676	770	907	996	1,102	1,150
	Basin Runoff*	441	440	440	440	440	439
	Total	1,117	1,210	1,347	1,436	1,542	1,589
Phosphate as PO4 (1,000 lb/day)	Domestic	79	94	111	124	134	141
	Industrial	56	58	60	62	63	64
	Sub-Total	135	152	171	186	197	205
	Basin Runoff*	14	14	15	15	15	15
	Total	149	166	186	201	212	220
Nitrogen (1,000 lb/day)	Domestic	54	65	76	85	92	96
	Industrial	8	8	9	10	10	10
	Sub-Total	62	73	85	95	102	106
	Basin Runoff*	14	14	15	15	15	16
	Total	76	87	100	110	117	122
Chlorides (1,000 lb/day)	Domestic	424	506	596	663	721	755
	Industrial	86	91	96	104	108	111
	Sub-Total	510	597	692	767	829	866
	Basin Runoff*	429	447	465	484	502	520
	Total	939	1,044	1,157	1,251	1,331	1,386
Sulfates (1,000 lb/day)	Domestic	357	426	502	558	607	636
	Industrial	82	85	89	93	97	102
	Sub-Total	439	511	591	651	704	738
	Basin Runoff*	ND**	ND	ND	ND	ND	ND
	Total	-	-	-	-	-	-

*Average Daily Loads and Flows - Based on 1/365 times Total Annual Runoff Loads and Flows

**No Data Available

C. EFFECTS OF CONTINUING PRESENT WATER MANAGEMENT STRATEGIES

The extensive water management planning carried out recently by the Three Rivers Watershed District and the Ohio Department of Natural Resources has been oriented toward the basic goal of meeting existing water quality standards and criteria for various uses. It is believed that if the Northeast Ohio Water Development is implemented on schedule, that this goal will be attained. If the water quality standards were met throughout the study area, it would represent a most significant startling improvement over present conditions.

However, the present water quality standards are not perfect, and in some respects do not adequately describe the quality of water that the public desires. The studies conducted by Three Rivers Watershed District discuss this matter, and present certain recommendations toward improvement of the Standards. The State of Ohio has indicated that the Standards are subject to revision as the need arises, and it may be confidently predicted that substantial upgrading of the goals for water quality will be made within the next decade. In this context, it is probable that modifications may be required in the water management plans to achieve goals which are revised substantially upward from present standards.

Recent emphasis has been placed on improving degree of treatment and expanding capacity of municipal and industrial wastewater treatment plants. These improvement programs are generally under way throughout the study area, and should show significant results within the next two years. Increased attention should be focused on improvements to the sewer collection systems, to prevent combined sewer overflow and discharge of polluted storm runoff. It is obvious that refinement of treatment processes to achieve 95 to 99% removals is useless if substantial quantities of wastewater are being discharged to Lake Erie with no treatment whatever. It appears, then,

that pollution control planning should be carried to greater detail within the municipal and industrial sewer systems.

Furthermore, present planning is severely hampered by lack of accurate information on the sources of wastes, their composition, and how waste discharges vary under different conditions. Better monitoring and surveillance systems are urgently needed, to permit the development of useful water quality models and enforcement procedures.

IV

DEVELOPMENT OF ALTERNATIVES

APPENDIX II

HAVENS AND EMERSON LTD. CONSULTING ENVIRONMENTAL ENGINEERS

IV - DEVELOPMENT OF ALTERNATIVES

A. BASIC OBJECTIVES AND GOALS

In the development of alternative strategy plans, the basic goal established by the Corps is defined as the best level of pollution control feasible under present technology. This goal represents a departure from past planning for water management, which has generally aimed at meeting present water quality standards or at preventing further degradation of present water quality. Achievement of this goal would result in better water quality in some respects than that called for by existing water quality standards, although no practical difference would result with respect to certain parameters.

Achievement of the stated goal is contingent upon meeting certain specific objectives, which will be briefly listed before considering in detail the technical systems and alternatives developed to achieve them. These objectives are:

1. Advanced wastewater treatment for high degree removal of BOD and suspended solids.
2. Partial nutrient removal, including denitrification in certain treatment systems.
3. Separation and special treatment of toxic materials.
4. Increased control and more effective treatment of industrial wastes.
5. Control of combined sewer overflows and polluted surface runoff.
6. Improved control of erosion, sediment and dredgings.
7. Special systems for improving the lower navigation channel reach of the Cuyahoga River.

For purposes of this feasibility study, the terms "water disposal" and "land disposal" systems have been adopted. These terms are somewhat ambiguous and not entirely satisfactory, since it is impossible to conceive of a disposal system which utilizes exclusively either water or land as a treatment or disposal mechanism. As used herein, the term "water disposal system" refers to a system in which water-borne wastes are collected and treated in treatment plants, with the purified effluent being released to receiving waters or recycled for re-use. The separated solids are normally disposed of on land or are incinerated. The term "land disposal system" as used herein refers to a system in which the water-borne wastes are applied to the land for treatment, in a number of possible schemes, with the treated effluent being returned to the hydrological cycle either through underground aquifers or surface streams. Solid materials would be disposed of on land. Many of the purification mechanisms operative in these two systems are essentially identical, and differ only in the details of their application.

B. GENERAL DESCRIPTION OF TREATMENT SYSTEMS CONSIDERED

1. WATER DISPOSAL SYSTEMS

Water based disposal methods are the methods of wastewater treatment almost universally used in the United States. All large urban wastewater treatment plants treat their wastewater in a water-borne system, and discharge treated effluents to watercourses, lakes or the ocean. This is a direct result of the fact that historically sewage is collected in an aqueous medium.

In 1855 the first comprehensive sewerage project in the United States was designed for the City of Chicago.[1] The growth of sewered areas has been extremely rapid. By the year 1935 approximately 91 percent of the total urban population was served by sewers. Today, almost all urban inhabitants are served by a sewerage system. The earliest form of sewage treatment was by dilution in the receiving stream; sewers discharged to the nearest stream without treatment or diffusion. By 1885, three methods of sewage treatment were known: broad irrigation; chemical precipitation; and intermittent sand filtration. Plain sedimentation was introduced to the United States in 1891, and Imhoff tanks were developed about 1900. The year 1916 brought the construction of the first activated sludge plant in the United States. During the 1920's mechanical aeration was introduced, and during the past twenty years, extensive development and improvement of the activated sludge system has taken place. During the past decade, great progress has been made in understanding and controlling biological oxidation processes, and vastly improved techniques are coming into design. Within the last three years, advanced waste treatment processes have recently begun to be explored and applied on substantial scale.

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1. Modern Sewage Disposal, edited by Langdon Pearse, Lancaster Press, Inc., Lancaster, Pa., 1938.

Suspended Solids Removal

All wastewater treatment plants make provisions for the removal of suspended solids. Various pre-treatment, primary treatment and tertiary treatment processes are employed to remove suspended materials.

Preparatory treatment includes racks, screens, grit chambers, or detritus tanks. Pre-treatment methods are provided to protect pumps and to remove large objects and floating material. Coarse racks may have two inch or larger openings while medium racks have openings of 1/2 to 1-1/2 inches. Racks can be manually or mechanically cleaned. Screens having openings on rotating discs or drums and are cleaned mechanically. Grit chambers are designed so that only heavier solids such as sand and gravel will settle out. Detritus tanks are similar to grit chambers except that large organic solids are also allowed to settle out, and are subsequently washed from the grit.

Primary treatment consists of sedimentation or flotation and involves the separation of settleable solids. Tanks are normally eight to twelve feet deep and may be of circular or rectangular construction. A detention period of 45 minutes to two hours may remove twenty-five to thirty-five percent of the applied BOD and fifty to seventy percent of the influent suspended solids. Flotation involves the conversion of settleable solids to floating matter by entraining the solids in upward moving gas bubbles. Flotation requires smaller tank sizes than does sedimentation and flotation also removes grit and grease along with suspended solids. Disadvantages of flotation over sedimentation are higher operating costs and reduced efficiency.

Microstrainers can be used as a tertiary treatment process. The screen material has openings on the order of twenty microns. The units are typically in the form of rotating drums. Rapid sand filtration is also used as a

tertiary process to remove final residues of fine solids which may escape gravity settling. Filters may be of sand or synthetic media, operated either under gravity or pressure flow, and are capable of producing sparkling clear, solids-free effluents. Filters are often preceded by a flocculating chemical addition.

Removal of Colloidal Material

Colloidal material is maintained in suspension by the small particle size, hydration, and surface charge on the particles. The particles which are on the order of one to 200 millimicron exhibit Brownian motion, and may be of organic or inorganic composition.

Chemical coagulation can be used to neutralize the surface charge and to aggregate the particles into flocs to promote sedimentation. The process involves adding the chemicals, flash mixing, flocculating, and settling. Coagulants that are commonly used include alum, ferric sulfate, ferric chloride, and various polyelectrolytes.

Removal of Dissolved Organic Solids

Secondary treatment utilizes aerobic microorganisms to oxidize complex organic materials. The microorganisms utilize the organic matter as a source of food and energy. The result is an oxidation of organics to simpler materials and the consequent reduction in BOD.

Most municipal wastewater treatment plants employing secondary treatment use some form of activated sludge. The basic activated sludge system consists of an aeration tank followed by a clarifier with provision for recycling activated sludge. Microorganisms contained in the aeration tank stabilize organic materials. Sludge, consisting of active, microbial flocs is constantly returned in order to maintain the proper food to

microorganism ratio in the aeration tank.

The mixed liquor volatile suspended solids (MLVSS) concentration in the aeration tank is normally maintained at about 2,000 mg/l. Activated sludge removes 85 to 90 percent of the applied BOD. There are several modifications of activated sludge including: complete mix systems, step aeration, extended aeration and contact stabilization.

Trickling filters are also used to remove dissolved organic matter by biological oxidation. Wastewater is trickled through a bed of stone or synthetic media. Removal of organics is accomplished by the action of the biological slime layer on the filter media. Effluent may be recirculated in order to increase the time of contact.

The chief advantage of the activated sludge system is the capability of high BOD reductions, and flexibility in design to deal with a wide variety of wastewaters. It is the system commonly being employed today, and is generally regarded as superior to the trickling filter.

Removal of Dissolved Inorganic Solids

Dissolved inorganic solids can be removed by electro-physical-chemical processes. Some processes that have or could be used to remove dissolved solids include: distillation, freezing, gas hydrate formation, ion exchange, electrodialysis, reverse osmosis, and adsorption. These processes would require a high degree of pretreatment. A concentrated residue would remain which would have to be disposed of in a fashion that will minimize deleterious effects on our environment.

Distillation would involve the evaporation of water from the wastewater at maximum temperatures of 350 to 400°F. The product water is then collected by condensation. Costs could be reduced by operating the process in parallel with a cheaper process such as adsorption.

Gas hydrate formation and freezing are similar processes; in fact, gas hydrate formation is a high temperature freezing process. The process involves the partial freezing of the wastewater and separating the ice or hydrate. The ice would then be melted as the product water. Process efficiency would be limited by the degree of washing of the hydrate or ice before melting. Propane, methyl bromide, or ethyl flouride could be used in the hydration process. These processes would utilize conventional equipment, present no scaling problems, and would have low energy transfer requirements.

Ion exchange involves the reversible interchange of ions between a solid media and the liquid waste. The combination of anionic and cationic medias or resins can result in a good quality product water. Natural and synthetic zeolites are commonly used as resins.

Selective membranes can also be used to remove or concentrate dissolved solids. In electrodialysis, ions move across a series of membranes under the influence of an applied electrical potential. In a reverse osmosis process the fluid is forced across the membrane under the influence of a hydrostatic pressure greater than the osmotic pressure. Membrane treatment processes are very susceptible to fouling of the membranes.

Adsorption is a surface phenomenon. Ions and colloidal particles are attracted and sorbed on the surface of the adsorbent. This is a reversible process that will eventually reach equilibrium. The adsorbent must be capable of being regenerated. Powdered and granulated activated carbon is the most commonly used adsorbent in wastewater treatment.

Disinfection

Disinfection is the destruction of waterborne microorganisms by physical and chemical means. Methods of disinfection that could be used include: boiling, exposure to ultraviolet light, application of halogens (chlorine,

bromine, iodine), application of strong oxidizing agents (potassium permanganate,hydrogen peroxide, ozone), and extreme pH conditions. The most commonly used disinfection method is chlorination.

Nutrient Removal

Much has been written recently concerning the role of nutrients in the eutrophication of our lakes and rivers. It appears that phosphorus is the critical element in algae growth. Nitrogen is critical to algae; however, some forms of algae are capable of fixing atmospheric nitrogen if no soluble nitrogen is available. It appears that phosphorus inputs to the watercourses must be controlled if we are to alleviate the problems of frequent algae blooms.

Nitrogen compounds not only serve as nutrients, but unoxidized forms of nitrogen constitute a significant oxygen demand. Nitrifying bacteria are capable of converting ammonia to nitrites and then to nitrates.

Phosphates can be removed by precipitation with ferric chloride or alum. Nitrogen can be removed in two ways. A typical secondary effluent has the majority of its nitrogen in the form of ammonia. Ammonia could be stripped in gaseous form from the effluent, which would effect a significant reduction in total nitrogen. A secondary effluent could be aerated for a prolonged period to promote nitrification. If the nitrified waste was then placed under anaerobic conditions, denitrifying bacteria would reduce the nitrates to nitrogen gas. The denitrified effluent would then have to be re-aerated before its release to the stream.

Recommended Treatment Processes

The estimated efficiencies of various unit processes used in wastewater treatment are shown in Table IV-1. It must be remembered that these percent

reductions represent only average estimates, prior to detailed design studies.

Five combinations of unit processes have been selected for preliminary consideration in the feasibility study. These complete treatment schemes are shown on Table IV-2 with the estimated treatment efficiencies. Figures for phosphate removal of spray irrigation systems given in Table IV-2 were developed as follows:

The total annual phosphate load applied per acre was calculated, from which was deducted the weight of phosphate estimated to be taken up by cover crops. The residual phosphate enters the soil, of which a portion, estimated at 50%, is absorbed, and after long-term equilibrium is established, the remaining 50% is assumed leached out with the percolate. A mass phosphate balance was computed on this basis, adjusted for water lost to evapo-transpiration, from which the percentage removal shown in the table was calculated.

The first is a total water renovation system. This would involve secondary treatment using activated sludge followed by tertiary treatment processes and nutrient removal processes. The second represents a land treatment system. Treatment would consist of biological stabilization in aerated lagoons followed by spray irrigation of the chlorinated effluent. The third is a land treatment system consisting of biological stabilization in aerated lagoons followed by high rate application to an artificially constructed spreading-percolation basin. The fourth is a combination treatment system. Wastewater would receive secondary biological treatment followed by spray irrigation of the chlorinated effluent. The fifth is also a combination system, consisting of secondary biological treatment with phosphate removal followed by application to land in a spreading basin for rapid flow through an underdrained percolation bed. The removal efficiencies given in the table were used to compute residual loads and impacts in a later section of the report. The treatment schemes are shown in the Attachment 5 Figures A-1 to A-5.

TABLE IV-1

ESTIMATED AVERAGE EFFICIENCIES OF UNIT PROCESSES USED IN WASTEWATER TREATMENT

Unit Processes	Percent Removals* BOD	Suspended Solids	Metal	Phosphates	Total Nitrogen	Bacteria	Viruses	Dissolved Solids
Pre-Treatment	5-	5-	0-	0-	0-	0-	0-	0-
Primary Sedimentation	30-	50-	20-	10-	0-	50-	10-	0-
Chemical Coagulation	75-	90-	50-	90-	0-	60-	90-	0-
Biological Secondary Treatment	-85	-90	-50	25-	30-	80-	75-	0-
Secondary Treatment in Lagoons	-80	-90	-10	10-	0-	95-	70-	0-
Microscreens (After Secondary Treatment)	-93	-93	0-	0-	0-	90-	90-	0-
Rapid Sand Filtration (After Secondary Treatment)	-97	-98	0-	0-	0-	95-	90-	-10
Phosphate Removal	0-	0-	0-	-95	0-	0-	0-	0-
Nitrogen Removal	0-	0-	0-	0-	85-	0-	0-	0-
Ion Exchange	60-	0-	90-	98-	80-	0-	0-	85-
Adsorption	-96	-96	10-	10-	10-	60-	35-	40-
Disinfection	0-	0-	0-	0-	0-	-99.9	-99	0-
Storage	5-	5-	0-	0-	0-	10-	10-	0-
Irrigation and crop	-98	-97	0-	61-	-79	99-	99-	0-
Spreading-Percolation	-96	-94	0-	0-	-38	0-	0-	0-

*80-90 Indicates 80% reduction by the particular unit process and 90% total reduction to that point.

TABLE IV-2

ESTIMATED AVERAGE EFFICIENCIES OF TREATMENT PROCESSES STUDIED*

		Total Percent Removals									
Type of Treatment	Processes Employed	BOD	COD	Susp. Solids	Heavy Metals	Phos-phates	Total Nitrogen	Oils, Grease	Diss. Solids	Bacteria	Viruses
Water	Preliminary Treatment Primary Sedimentation Activated Sludge Secondary Chemical coagulation Nutrient removal Settling Mixed Media Filtration Disinfection	97	92	98	75	95	90	95	10	99.9	99+
Land with spray irrigation	Preliminary Treatment Aerated Lagoon Secondary Disinfection Storage Spray Irrigation	98	96	97	10	61	79	60	0	99.9	99+
Land with spreading-percolation	Preliminary Treatment Aerated Lagoon Secondary Disinfection Storage Spreading-Percolation Phosphate Removal	96	91	94	10	95	38	50	0	99.9	99+
Combination, with Spray Irrigation	Preliminary Treatment Primary Sedimentation Activated Sludge Secondary Disinfection Storage Spray Irrigation	98	96	97	50	65	79	60	0	99.9	99+
Combination, with Spreading-Percolation	Preliminary Treatment Primary Sedimentation Activated Sludge Secondary Phosphate Removal Disinfection Storage Spreading-Percolation	96	91	94	50	95	38	50	0	99.9	99+

*Line diagrams are shown in Appendix V.

2. LAND DISPOSAL SYSTEMS

In the United States, there are over 1,300 smaller communities or industries that return their wastewater to the land by irrigation techniques. There are others that utilize a land disposal system through other methods such as lagooning or deep well injection. Spray irrigation and ridge and furrow irrigation are two-fold in purpose: first, the nutrient rich effluent acts as a soil conditioner in increasing the fertility of the soil, and second, in arid areas, the wastes may be used as a source of water, or for recharging the ground water system. In this section, the following land disposal techniques are discussed: waste treatment lagoons; use of effluents for irrigation; disposal by permanent storage; and spreading-percolation basins.

Waste Treatment Lagoons

Waste treatment lagoons are commonly referred to as stabilization ponds and can be either aerobic, facultative or anaerobic in nature. Anaerobic lagoons rely on anaerobic microorganisms to stabilize degradable substances in the continuous absence of oxygen, and are not applicable to the rates considered herein. Facultative lagoons utilize both an aerobic surface horizon and an anaerobic bottom horizon to stabilize waste materials. Algal photosynthesis acts to supply oxygen to the microbiologic populations. Mechanical or bubble aeration may be provided to maintain aerobic conditions, in which case the lagoon is referred to as an "aerated lagoon".

Lagoons are designed with a loading rate varying from 50 to 1,000 lbs. BOD/acre/day, depending upon the type. Pretreatment of the wastewater is usually included in those lagoons treating domestic or municipal waste.

Large land area required for lagooning wastes of the magnitude considered herein, and the possibility of ground water pollution are two disadvantages

of lagoons. The concentration of wastes in a lagoon relative to land area could have adverse effects on the underlying soils. For purposes of this study, artifically aerated oxidation lagoons are the only type considered because of the higher permissible loading and lower land requirements.

Use of Effluents for Irrigation

Utilization of sewage plant effluent for agriculatural purposes has gained increasing attention in recent years. Several systems have been developed not only for disposal and treatment of these wastes, but also benefitting the farmland with nutrient-rich material. Both liquid effluent and sludges have been used in various combinations in increasing soil productivity: sludge as fertilizer, composting sludge and municipal wastes, spray irrigation and ridge and furrow irrigation.

Sludge applications as fertilizer have been used for many years in both the Orient and Europe as well. The nutrient values of sludge vary, however, with the type of treatment the sewage undergoes:

Treatment Technique	N%	P_2O_5%	Humus %
Primary	2.2-4.0	1.0-3.0	33
Raw Activated	4.0	6.0	41
Digested	2.0	3.0	35

The sludge is relatively low in nitrogen (N) and phosphorus (P) and low to very low in potassium (K). The average agricultural fertilizer (20% nitrogen - 20% phosphorus - 10% potassium) is far higher in fertilizer values than sludge, and therefore the sludge acts more as a soil conditioner than as a fertilizer.

Spray irrigation involves the distribution of liquid wastes on the land by spraying. The wastewater requires pretreatment, i.e. primary treatment to remove solids, secondary treatment to reduce BOD and suspended solids,

and disinfection to reduce bacteria. The liquid effluent is pumped onto the croplands, grasslands or woodlands either directly or after storage.

Spray irrigation, as a method of wastewater treatment, has been effectively utilized at small scale applications. Several canning industries, food packers, paper mills and dairies have been treating wastes by percolating the effluent through the soil since 1938. The effectiveness of the "soil filter" is dependent upon the contact time between the soil and the liquid, which in turn, is determined by the grain size and unsaturated depth of the soil. Besides geological conditions, climatic conditions must be taken into account. Temperature range and variation affect the biological decomposition of the effluent. Lastly, biological systems of the soil determine the total adsorptive capacity of the soil, as well as runoff and percolation characteristics. Plant roots affect the infiltration of the soils; the larger and more numerous the roots, the greater the infiltration rate. Plants also affect the nutrient assimilation rate, as well as the rate of evapo-transpiration.

Ridge and furrow irrigation is similar to spray irrigation, with the exception that the wastes would be spread across the land in irrigation furrows rather than sprayed. Also, the total treatment plant waste is utilized, instead of just the liquid effluent. The liquid wastes are introduced into the furrows at the high end of a gradually sloped field through a series of distribution channels. Crops are grown on the ridges between irrigation furrows.

Ridge and furrow irrigation was judged to be unsatisfactory for use in Northeastern Ohio. The rolling topography found in this section of the state would necessitate extensive grading to provide a suitable distribution system. The grading process, beside being very costly, would remove valuable topsoil.

The more important facets of the use of effluent for irrigation have been separated out for discussion.

Salinity - As wastewater percolates through the soil, the soil tends to concentrate dissolved salts. As these salts, together with fine solids, concentrate in the upper few inches of soil, they affect the soil pore size and in turn the infiltration rate. Fine and medium grain soils tend to clog more readily than larger soil particles or aggregates. The effect of salinity on the inter-relationship between soil and plant is even more dramatic, for salinity affects the health of the plant and the availability of water for plant consumption. Plants have been known to wilt in soils properly irrigated, but having a high salinity level within the root zone.

Pesticides - With the current and projected use of pesticides, herbicides and rodenticides, traces of these toxic compounds in our wastewater could prove to be crucial to the overall health of the environment.

Pesticide persistence in soils is dependent on the particular compound, the rate of application, temperature, and the characteristics of the soil such as acidity, organic content and moisture. Pesticide residues containing a heavy metal such as lead or arsenic continue to increase with each application. Most of the pesticide applied is contained in the upper layers of the soil, usually in the top inch or two. According to experimentally derived information, a period of several hundred years would be required for deildrin to be transported in solution at a residual concentration of 20 ppb to the depth of one foot in natural soils. Thus, the problem of penetration of pesticides by percolation may be insignificant, while the problem of runoff is quite different.

The annual runoff of all streams in the United States averages about 1,160 BGD. If the 466 million pounds of pesticides sold in 1958 were

diluted by the average annual runoff of all streams, the resulting pesticide concentration would be about 0.13 ppm. Toxicity to some species of birds and fish is around 0.03 ppm. Not all pesticides percolate or result in stream runoff; some are incorporated into plant systems or remain as residues. A part is lost by volatilization while a small portion is subject to biologic attack or oxidation. Lindane, DDT, heptachlor, and endrin are resistant to biologic breakdown.

Two chlorinated hydrocarbons, Dieldrin and Endrin have shown to cause an increase in BOD. In the range of 0-2 mg/l of Dieldrin, the product caused an average increase in BOD of 130 mg/l. In the range 0-5 mg/l Endrin caused an average increase in BOD of 40 mg/l for each mg/l increase in pesticide concentration. In the range of 0-2 mg/l of equal pesticide mixtures, the average increase of BOD was 80 mg/l for each mg/l increase in the pesticide mixture.

Numerous methods have been employed in attempting to remove pesticides from wastewater. Several investigations have been summarized to construct this table:

TABLE IV-3

EFFECTIVENESS OF PESTICIDE REMOVAL

Compound	Ozonation	Potassium Permang.	Chlorination	Peroxides	Aeration	Alkaline decomp.	Act. sludge	Photochem. degradation	Activated carbon w/ sand filt.
Lindane	0	*	X	X	X	0			0
Aldrin	0	0	0	X	0			*	
Dieldrin	0	X	X	X	0			X	0
Endrin		X	X					X	0
Heptachlor		0	*						
DDT		X				0			0
Malathion					0		0		

0 - 60% removal effectiveness; * - 60%-40% effectiveness; X - 40% < effectiveness.

The real question of pesticide usage is two-fold - What are the long range effects on the environment, and what are the synergistic effects? Definitive answers to these questions are not available at present.

Trace Elements and Compounds - Trace elements are those which normally occur in very small quantities. Trace element ions are present in wastewater. The source of these ions is natural as well as a result of man's activities. Although complicated by interactive (synergistic) effects of soil and plant characteristics, nutritional effects are not as serious as possible phytotoxicity which may be caused by trace elements.

Some trace elements are essential for plant growth in very small quantities while others are non-essential. When an element reaches toxic proportions, one of two results are possible. First, the element may decrease in concentration so that it is no longer toxic. Second, it may increase the "storage" of that element in the soil. Beyond that, some elements are taken up by the ground cover and incorporated into the root system, and plant toxicity results. Table IV-4 presents the effect of various metals on biological treatment and on the soil-plant systems.

Bacteria - Viruses - Another factor entering into the suitability of spray irrigation is the presence of bacteria and viruses as the water is directly applied to the portions of the plant above ground. Public health considerations exclude the use of spray irrigation on crops for human consumption.

Other factors influence the survival of pathogenic bacteria in soil and on vegetation. Characteristics such as lower temperatures, higher moisture content, pH, moisture holding, relatively high organic content, affect the viability of bacteria.

The researches of Flugge, C. Frankel and others show that the bacteria

TABLE IV-4

EFFECTS OF TRACE ELEMENTS AND

Element or Compound	Industries Commonly Discharging by SIC Numbers	Will the Element Affect Biological Treatment: Yes	No	Remark	Will Biological Treat[ment] Affect the Element: Yes	No
Antimony	282,285,289,303,221,222, 224,229,281,311,313,325, 329,331,332,333,334,335, 336					
Arsenic	287					
Barium	281,282,286,303,321,322, 323,324,325					
Beryllium	344,369					
Boron	227,228,242,249,261,284, 286,311,313,321,322,323	0.05 mg/l affects process		Causes sludge not to settle - concentration of .05 mg/l requires 2-3 hrs. for sludge to recover.		
Cadmium	108,221,222,224,229,281, 283,289,325,329	Effects O_2 uptake		Acclimation period necessary		
Chromium	221,222,224,229,281,283, 311,313,321,322,323,325, 329,347	Low concentrations 30% drop in BOD. Massive doses severe effect.	>50 mg/l continuous feed	Sludge dose requires acclimation period restrains odor.	Retention occurs largely in activated sludge.	>5 ple <5 add sou
Copper	221,222,224,229,261,281, 282,286,347,354	0.4-25 mg/l reduce BOD 0-7%	<1 mg/l	>50 mg/l copper and 10 mg/l copper cynanide increase turbidity and have slight effect.	50-79% removal for a range of 0.4-25 mg/l	30- for Rem wou
Cyanide	281,289,291,347		X	After system is acclimated, no significant effect.	X	Des aer sys
Fluoride	281,287,289,291,299,325, 331,367,386,387					

2

TABLE IV-4

RACE ELEMENTS AND COMPOUNDS

ll Biological Treatment Affect the Element: No	Remark	Effect of the Element on Soil Disposal System: Trace Element Tolerances For Agriculture: Long Term mg/l	Short Term mg/l	Remark	Will Soil Disposal Method Affect the Element: Yes	No	Remark
		1.0	10.0	Fixed by soil in relatively insoluble form, destroys chlorophyll in foliage.	X		Heavy soils (clay & adobe clay) "fix" large amounts rendering it unavailable to plants.
				Non-essential to plant growth, toxic to plants in very high concentrations			
		0.5	1.0	May cause "beryllium rickets" in animals, excess forms phosphate, which is released by intestine.			
		0.75	2.0	Growth retarded and toxic when in high concentrations (100-217 ppm)		X	Plant roots dissolve Boron, but plants do not absorb it.
		.005	0.05		X		Plants will absorb cadmium.
ation rs largely ctivated ge.	$>$5 mg/l complete removal. $<$5 mg/l chromate added as oxygen source.	5.0	20.0	Toxic to barley, corn, oats, sugar beets at levels of 5 ppm. Chromate form particularly toxic.	X		Plants will absorb chromium.
% removal a range of -25 mg/l	30-50% in soluble form. Remainder (insoluble) would not react.	0.2	5.0	Accumulates in topsoil-absorbed to silicate mineral surfaces or chelate by organic matter.		X	Virtually all Cu is "fixed" in surface soil by organic matter and microorganisms.
X	Destroys acclimated aerobic biological system.						
		No Limit Proposed	No Limit Proposed	100 mg/l severely injures peaches and buckwheat. 200 mg/l kills peach, tomatoes and buckwheat.		X	Absorption in plants unrelated to content in soil.

TABLE IV-4 (CONT'D.)

Element or Compound	Industries Commonly Discharging by SIC Numbers	Will the Element Affect Biological Treatment — Yes	Will the Element Affect Biological Treatment — No	Remarks	Will Biological Treatm[ent] Affect the Element — Yes	Will Biological Treatm[ent] Affect the Element — No	[cut off]
Iron	331,332						
Lead	108,281,286,289,307,369, 399	<0.1 mg/l		0.5 mg/l retard growth of protozoa and nitrification. 0.1 mg/l toxic to biological oxidation.			
Magnesium	283,289,311,313,324,325, 329,361,362,363,364,365, 366,367,369,383,386						
Manganese	281,287,387,352						
Mercury	283,321,322,323						
Nickel	347	2.5-10 mg/l reduce BOD removal by max. 5%	1-2.5 mg/l	Increase turbidity in final effluent resistant to doses after acclimation period.	30% removal		Abou[t] solu[...] thro[...]
Selenium	281,286,303,321,322, 323,361,369						
Silver	282,284,289,347,386,395						
Vanadium	221,282,286,321,322,323						

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IV-4 (CONT'D.)

Biological Treatment Affect the Element		Effect of the Element on Soil Disposal System: Trace Element Tolerances For Agriculture			Will Soil Disposal Method Affect the Element		
No	Remarks	Long Term mg/l	Short Term mg/l	Remarks	Yes	No	Remarks
				Necessary in small amounts for plant nutrient - toxic when present with disproportional amount of manganese.			
		5.0	20.0	>0.5 mg/l poisonous to animals concentrations of 2-200 ppm lead chloride not harmful to plant.			Most Pb is "fixed" in soil and is taken in the roots of plants at concentrations of 10 ppm
		10.0	20.0	Magnesium cations keep soil permeable and in good till.			
		2.0	20.0	Used to enrich soil and essential to plant growth.	X		Absorption of manganese highest in reproductive portions of plant.
					X		Under normal conditions reduces to metallic form in topsoil.
	About 70% soluble passes through system.	0.5	2.0	Readily available to plants, toxic effect more pronounced as pH decreases . Tomato toxic level - 40 ppm			Not appreciably absorbed by plant chelated form looses almost all toxicity.
		0.05	0.05	Poisoning occurs at 1-6 mg/kg within top 8 inches.	X		Some plants readily absorb and replace sulfur with selenium in amino acids.
		10.0	10.0	<0.5 mg/l toxic to plants			

of soil do not penetrate deeply, but decrease in number with depth.

Contradictory experience was obtained in southern California percolation disposal of wastewater effluents, which indicated a decrease in bacteria in upper layers followed by a substantial increase in lower strata.

With sewage treatment techniques improved, more than 99% of the coliform organisms and enterocci are removed by primary sewage treatment and chlorination; high level inactivation can be obtained in both treated and untreated domestic sewage. Present chlorination practices (one mg/1 of residual), however, are inadequate for a high level of virus inactivation.

Complete virus inactivation may be obtained in secondary treatment plants which employ a high degree of nitrification. This conversion of ammonia to nitrates would allow the effluent to be chlorinated to the break-point and to produce free chlorine residuals with relatively low chlorine dosages.

Certain sources provide early indication that soil percolation systems may provide nearly 100% removal of viruses. Research has shown that some viruses are transformed into innocuous proteins as they pass through the soil. These conclusions are very preliminary, based upon meager data, and much research is needed to define the action of these systems on viral organisms.

Ground Cover - A cover crop is essential in order to increase the rate of absorption and evaporation and transpiration, and to prevent soil erosion. Usually the rate of absorption into the soil is increased several times with the use of a good cover crop, and in addition, plant transpiration accounts for considerable disposal of water and uptake of nutrient materials. The differences in relative liquid loss give some indication in the effectiveness of a ground cover.

Table IV-5 summarizes the general range of removals associated with land

disposal, with and without a cover crop. It is presumed that the removals are associated with application rates of nutrients not in substantial excess of the nutrient requirments of the crop. Very heavy applications, (such as from continuous sewage application) may exhibit lower removals.

TABLE IV-5

EFFICIENCIES OF REMOVAL

Silt Loam Soil	COD Removal	ABS Removal	Ammonia N Removal	Total N Removal	Total P Removal
Bare	91%	67%	96%	48%	98%
With Canary Grass	84%	78%	96%	85%	99%

The phospate removal shown in Table IV-5 is based on field observations of phosphorous uptake at low loading range in which the plant uptake in soil absorption capacity were substantially higher than the load applied. As pointed out above, this may not be the case when dealing with relatively high phosphate loadings from sewage application on a continuous long-term basis.

A dense cover crop prevents soil erosion and the stripping of soil fertility by physically breaking the impact of water droplets, by providing needed storage space for water with the vastly increased surface area, by introducing water into the soil through the root system, by providing a soil binder through the root system, and by accounting for evapo-transpiration.

Nutrients - Nitrogen appears in the soil through a process of mineralization, the rate of mineralization equals the accumulation of organic nitrogen in the soil. The organic nitrogen is converted to ammonium ions. Some plants may utilize nitrogen in the ammonia form directly. Through a process of nitrification, ammonium ions are converted to nitrite ions, which in turn are converted to nitrate ions. This active form of N (nitrate ions) actively pass through the soil, and are utilized by crops. Part of the nitrogen may be lost through denitrification, in which poorly aerated soils

lose gaseous nitrogen to the atmosphere.

Ideally, the amount of nitrogen applied to soil in the form of wastes would equal that lost from soil in the form of plant protein plus the gaseous losses. There is a substantial body of experience in irrigation practice showing that excess nitrates may migrate long distances in the ground water.

Phosphorus behaves quite differently from nitrogen in soils, for it is more readily "fixed" in soils. Because of this ability to "fix", smaller quantities of phosphorus percolate into the ground water or appears in runoff. The ability of the soil to "fix" phosphorus is not unlimited, and breakthrough into percolant is possible after a number of years. The removals of phosphorus and nitrogen by some crops cultivated in Ohio are shown in Table IV-6.

TABLE IV-6

POUNDS OF PLANT FOOD REMOVED PER ACRE
PER GROWING SEASON BY CERTAIN CROPS

Crop	Cultivated in Ohio	Yield	Part of Crop	Nitrogen	Phosphorus
Alfalfa	X	6 Tons	Hay	335	20
Alfalfa/Grass	X	6 Tons	Hay	320	24
Celery	X	1000 Crates	All	230	52
Clover	X	4.5 Tons	Hay	185	17
Corn Silage	X	30 Tons		200	22
Sugar Beets	X	36 Tons	Root & Tops	275	24
Tomatoes	X	30 Tons	Fruit & Vine	250	22
Turf Grass	X	2.5 Tons Dry		390	29

When applying municipal effluent, the applied quantities are greater than the amount required for growing crops and the amount absorbed by the soil. Consequently, if high degrees of removal are necessary, the percolant would have to be collected and treated.

In determining design criteria for a spray irrigation system, several factors must be determined initially. Climate is the least controllable factor, with regard to temperature, precipitation and evapotranspiration. Although spray irrigation has been carried out under freezing conditions,

percolation rates are lower and system operations are difficult. Therefore, average temperatures above 32°F are necessary when spray irrigating. March through November exhibit acceptable temperature averages within the study area. Precipitation within the area averages 30 inches during the irrigation period March through November. Of that, approximately 21 inches will be lost to evapotranspiration.

Soil types and their effectiveness of removal are also important factors to consider. Table IV-7 compares efficiency of removals for various soil types after primary treatment. These factors were taken into account when determining the areas suitable for spray irrigation.

TABLE IV-7

SOIL TYPES AND PERCENTAGE OF REMOVALS

	% Removal							
Soil Type	BOD	COD	Total P	NO3-N	VS	Total N	ABS	NH^3-N
Sand	95%	80%				83%		99%
Sandy Loam	99%	96%	62%		98%	90%		
Loamy Sand	98%	66%						80%
Clay Loam	98%	93%	58%		97%	89%		
Silt Loam		91%	98%			48%	67%	96%
Loam	97%	93%	51%		95%	86%		
Clay	67%	74%	72%	50%	90%	80%		

According to the Ohio Irrigation Guide developed by various state and Federal agencies including the U.S. Department of Agriculture, various factors pertaining to soil types and irrigation rates were developed. Information was also used from a special study of North East Ohio soils conducted for Havens & Emerson by Terraneers, Inc. From this data the soils classified by Terraneers, as types G and Y series may be capable of receiving an average application rate of two inches per week.

In conclusion, spray irrigation is feasible within the study area, for a period of 30 weeks per year (Mid-March to Mid-November) at a design use rate of 2 in./wk., for a total of 60 in./year. Attachment 3 lists Northeast Ohio Soils and Attachment 4 gives Preliminary Design Criteria.

Disposal By Permanent Storage Through Deep Well Injection Or In Underground Cavities

Deep well injection on a large scale is not a true disposal method, but rather represents a storage technique. The actual technique of deep well storage is relatively uncomplicated, with wastes being pumped under pressure into porous or semi-porous horizons. Pretreatment would be needed to prevent clogging of pores. Care must be exercised to prevent underground water resources from becoming contaminated. In addition, disinfection may be desired to prevent microbiological growth.

In Northeastern Ohio, three methods of rock strata storage exist. Naturally occurring permeable zones are present within Northeastern Ohio. The Mississippian system characterized by Berea and Cussewego sandstones are fine-to-coarse grained. Contamination of the Berea must be avoided in those areas where it may be used as a source of water for human and agricultural purposes.

The Silurian system permeable zones lying within the Bass Island and Lockport dolomites and the Medina sandstones are possible disposal or storage zones. Little is known of the fluid transmission or storage characteristics of the Ordovician system. The Cambrian system is present within the Northeastern Ohio area, and is the disposal area preferred by many state agencies.

Artifically created wells can be developed through a process of hydraulic fracturing. The well is usually drilled in shale formations, at which time a steel casing is cemented into place. Depth is determined by local geology, but usually exists within 1,000-1,500 feet. A mixed water/sand jet cuts a slot near the bottom of the casing. High-pressure pumps force the mixture into the slot until the shale fractures, at which time cement is mixed with the waste and injected into the fractures. It is improbable, however, that conditions exist within the Northeast Ohio which would make this disposal method practical.

Strip coal mines can be prepared for the acceptance of sewage wastes; solids more readily than liquids. The economic feasibility of this method is also encouraging where the land has been reduced to scarred and worthless condition. Further study is needed as to the feasibility of sludge application in strip mines and underground mines.

Only one limestone mine exists within the study area, that being the Columbia Southern (PPG) mine at Barberton. Because of the limited disposal sites in this area, a premium exists on this location. It would be economically infeasible to store anything but wastes bearing very high disposal costs.

Within the Salina formation, which exists throughout the study area, lie extensive salt mines and dissolution cavities. Most of these cavities (Cleveland and Fairport Harbor) are privately owned and are not available.

Spreading and Percolation Basins

A modification of the "living filter" system employs the use of percolation basins as a tertiary treatment technique. The process itself entails the application of highly-treated activated sludge to a bed of pea gravel and sand which serves to flocculate the colloidal solids and acts as a media for growth of biological organisms. As the effluent percolates to the ground water, removals are effected. Normally, filters have some sort of underdrainage collection gallery which must be located above ground water table. Percolation basins act as biological oxidation beds, and bacterial action may reduce organic material to various reaction end products which appear in the percolate. In addition, the leaching action of water on the soil may affect the quality of the effluent. These effects are illustrated for one soil type by data from a 2-1/2 year test at the Whittier Narrows test basin in Southern California* conducted by the California Institute of Technology for the California Water Quality Control Board.

* "Waste Water Reclamation at Whittier Narrows" (1966) California Institute of Technology

(1964 average)

Total Solids	+136%
Total Volatile Solids	+182%
COD	-39%
ABS	-91%
NO_2 as N	+655%
NO_3 as N	+134%
Ammonia as N	-95%
Total N	+104%
PO_4	-96%

(+) Increase in concentration (-) Removals

The soil must remain aerobic between the surface and the ground water table. This condition is best maintained if the soil system is allowed to rest between applications of liquid.

Two specific problems arise within the percolating basins: coliform growth and lack of dissolved oxygen. Fecal organisms are removed by filtration, but non-fecal coliforms multiply in the organically rich, damp and aerated soils, and methods of control are needed. Also, if dissolved oxygen is only provided by the wastewater itself, carbonaceous and nitrogenous oxygen demands cannot be met. If however, nitrification is completed prior to spreading, then additional dissolved oxygen will be available for stabilizing other substances.

With frequent resting, an application rate of 12 inches/day might be expected to percolate for a period of months accompanied by a slowly decreasing infiltration rate. This rate is assumed in the preliminary design of this study.

Efficiencies of Land Disposal Systems

Efficiencies of these systems are shown on Table IV-1 and IV-2.

3. INDUSTRIAL WASTEWATER TREATMENT AND DISPOSAL

Importance

Industrial wastewaters represent a significant proportion of the total of all wastewaters produced in the study area. Almost all industrial wastewaters will affect, to some degree, the water quality of a receiving stream if no treatment is provided. All watercourses have the capability of assimilating a certain degree of contamination. When this assimilative capacity is exceeded, and the suitability of the water for downstream usage is impaired, the stream is said to be polluted. The following materials can be considered as possible pollutants: organic matter, toxic chemicals, color, radioactive materials, surfactants, acids or alkalis, suspended or floating matter, micro-organisms, heat and inorganic salts. Industrial wastes may contain significant concentration of any of the above list of contaminants. Some industrial wastes may have extremely deleterious affects on a watercourse, municipal sewerage system, or biological treatment process. Suitable provisions must be made for the collection, treatment, and disposal of contaminated industrial wastes. Many industrial wastes can be safely and satisfactorily released into the municipal sewer system for treatment at the municipal wastewater treatment facilities. The most troublesome industrial wastewaters require pre-treatment before release to the sewer system or separate treatment at an industrial wastewater treatment plant.

Segregation of Industrial Wastewaters

A significant percentage of all industrial wastes produced in the study area have adverse effects on municipal sewerage systems, on biological treatment processes, or on land disposal systems such as spray irrigation. These deleterious industrial wastes must be segregated and treated separately or pre-treated to remove the noxious contaminants before release to the municipal

TABLE IV-8

MATERIALS TO BE SEGREGATED

Type of Material	Reason for Segregation
Heavy Metals	Interfere with biological oxidation by interferring with enzyme systems and killing micro-organisms.
Inflammables	May cause fires or explosions
Noxious Gases	Present dangers to workers and public.
Cyanides	Highly poisonous - Toxic to humans and biological oxidation
Oils and Greases	Deposits in sewers, interferes with aeration. May create fire hazards, esthetic nuisance
Phenols	Interfere with biological oxidation. Cause taste and odors
Acids or Alkalies	May affect biological oxidation. May cause problems in sewers
Radioactive Materials	Public health hazard.

TABLE IV-9

INDUSTRIES PRODUCING WASTES TO BE SEGREGATED

SIC#	Industry	Reason for Segregation
281	Industrial chemical plants	M, O, P
289	Manufacturing of inks, adhesives, and misc. chemicals	M, O
301	Tires and inner tubes	B
331	Blast furnaces, steelworks, rolling and finishing mills	M, O, P, C
334	Secondary smelting and refining of nonferrous metals	M, O
339	Forging and misc. primary metal products	M, O
343	Heating apparatus and plumbing fixtures	M, O, C
344	Fabricated structural metal products	M, O, C
345	Screw machine products bolts, nuts, screws, rivets and washers	M, O, C
347	Coating engraving and allied services	M, O, C
362	Electrical industrial apparatus	M, C
363	Household appliances	M, C
371	Motor vehicles and motor vehicle equipment	M, O, C

CODE

M - Heavy Metals

O - Oils

P - Phenols

C - Cyanide

B - Adversely Affect Biological Treatment Facilities

TABLE IV-10

INDUSTRIAL WASTE LOADS
FROM SEGREGATED INDUSTRIES

	Loads (lb./day) 1970	2020
Silver		
Rocky	0.03	0.06
Chagrin	0.02	0.03
Cuyahoga	0.64	0.58
Lake	0.47	0.47
TOTAL	1.16	1.14
Copper		
Rocky	6	11
Chagrin	4	7
Cuyahoga	543	450
Lake	68	66
TOTAL	621	534
Chromium		
Rocky	80	160
Chagrin	60	130
Cuyahoga	560	1,670
Lake	1,370	1,350
TOTAL	2,070	3,310
Cadmium		
Rocky	3	5
Chagrin	13	30
Cuyahoga	414	348
Lake	22	22
TOTAL	452	405
Nickel		
Rocky	6	12
Chagrin	15	36
Cuyahoga	375	326
Lake	119	120
TOTAL	515	494
Lead		
Rocky	2	4
Chagrin	1	1
Cuyahoga	478	392
Lake	10	9
TOTAL	491	406

TABLE IV-10 CONT'D.

	Loads (lb./day) 1970	2020
Zinc		
Rocky	90	200
Chagrin	1,760	4,260
Cuyahoga	5,870	5,720
Lake	1,320	1,420
TOTAL	9,040	11,600
Iron		
Rocky	800	1,400
Chagrin	400	700
Cuyahoga	164,200	133,400
Lake	3,200	3,200
TOTAL	168,600	138,700
Tin		
Rocky	0.2	0.3
Chagrin	0.3	0.6
Cuyahoga	21.9	17.7
Lake	19.3	17.4
TOTAL	41.7	36.0
Cyanide		
Rocky	8	15
Chagrin	9	20
Cuyahoga	614	533
Lake	159	157
TOTAL	790	725
Phenols		
Rocky	2	5
Chagrin	0	1
Cuyahoga	327	280
Lake	8	9
TOTAL	337	295

TABLE IV-11

INDUSTRIAL WASTEWATER FLOWS FROM MAJOR INDUSTRIES

	FLOW (MGD)									
	SIC No. 347 Plating Industries		SIC No. 331 Steelmaking Industries		SIC No. 301 Rubber Industry		SIC No. 345 Screw Machine Products		SIC No. 281 Industrial Chemicals	
Area	1970	2020	1970	2020	1970	2020	1970	2020	1970	2020
Cuyahoga County	3.48	3.27	5.00	4.10	0.00	0.00	3.56	3.34	2.16	2.44
Akron Area	0.36	0.33	0.11	0.09	7.73	8.35	0.05	0.05	3.74	4.23
Rest of Basin	0.18	0.35	0.03	0.05	0.00	0.00	0.30	0.60	3.14	7.59
TOTAL	4.02	3.95	5.14	4.24	7.73	8.35	3.91	3.99	9.04	14.26
Navigation Channel	1.85	1.65	5.00	4.10	0.00	0.00	1.89	1.69	1.15	1.24

sewer. Table IV-4 lists the effects of certain elements on biological treatment and on irrigation systems. The types of contaminants that must be segregated are shown on Table IV-8, along with the reasons for their segregation. Industries that discharge wastewaters containing significant quantities of these contaminants should have these wastes segregated and treated separately. Segregated industrial wastes are summarized in Table IV-9 . The wastewater loads for the years 1970 and 2020 from certain segregated industrial wastes are shown on Table IV-10 and flows are summarized in Table IV-11. All industrial wastewaters that are not to be segregated are assumed to continue to discharge into municipal sewer systems.

System for the Treatment and Disposal of Industrial Wastes

All acceptable industrial wastes will be discharged into existing municipal sewerage systems and treated at municipal wastewater treatment facilities. The discharge of industrial wastewaters containing high concentrations of organic material or suspended solids would be accepted after partial reduction by pretreatment. Uncontaminated industrial cooling waters would be treated for removal of excess heat by the individual industries or recycled through cooling towers.

All segregated industrial wastewaters would be handled and treated to a high degree at the source or at a central industrial waste treatment plant. Wastes might typically be treated by the use of chemical coagulation followed by physical-chemical processes such as chemical precipitation, neutralization, pH adjustment, sedimentation, ion exchange, reverse osmosis, electrodialysis, or distillation. Additional unit processes would have to be added to remove unacceptable contaminants not removed by the basic processes above. It is assumed that such industrial waste treatment processes will yield a ninety percent product water recovery and a ten percent sludge residue by volume.

Two regional industrial wastewater treatment plants would be constructed. Industrial sewerage systems would be constructed along the Navigation Channel of the Lower Cuyahoga and in the industrial section of Akron. Industrial wastes not tributary to these industrial sewers would be treated on site. The product water would be available for reuse within the industrial plant. The sludge residue would be disposed of as described in a latter section of the chapter.

4. SLUDGE AND RESIDUE DISPOSAL

Large quantities of organic sludges are produced in conventional wastewater treatment plants. These sludges originate from primary sedimentation and from secondary biological treatment processes. Physical-chemical wastewater treatment processes yield a chemical precipitate sludge combined with organic sludge. Residues from industrial wastewater treatment plants may contain extremely high concentrations of inorganic solids, salts, or metal precipitates. These concentrated sludges and residues constitute a major pollution load. Provisions for the treatment and disposal of these wastes must be made in order to protect our land, air, and water resources.

Thickening

A large percentage of municipal wastewater treatment plants thicken the sludge produced during treatment. Thickening takes place in tanks designed to promote hindered sedimentation or by dissolved air flotation. The purpose of thickening is simply to reduce the volume of sludge to be handled. Typical loading rates for thickeners are on the order of 19 pounds of solids per day per square foot for a mixture of primary and activated sludge. Loading rates for activated sludge alone are about one half of the rates applied to mixtures of primary and activated sludges.

Centrifuges can also be used to thicken sludge. Centrifugation may thicken activated sludges to a solids content of roughly five percent, while digested, primary sludge may be thickened to solids concentrations of greater than ten percent. Horsepower requirements for centrifuging amount to about three horsepower-hour per 1,000 gallons of wet sludge.

Anaerobic Digestion

Many municipal wastewater treatment plants employ anaerobic digestion to partially stabilize the produced sludge. Digestion is accomplished in the absence of oxygen. Two classes of bacteria, acid formers and methane formers break down volatile organic material in the sludge. The advantages of digestion include: the transformation of a portion of sludge solids to liquid and gaseous materials, the reduction of water content, the improvement of sludge dewatering characteristics, reduction of pathogenic organisms, breakdown of fats and greases, and the production of a useful fuel gas. During the process volatile material may be reduced 55 to 65 percent, suspended solids may be reduced 30 to 35 percent, and coliform organisms may show a 99 percent reduction. The major disadvantages of the process include capital and operating cost, and recycling of nutrient-rich supernatant liquors. Sludge digestion is regarded as a necessary step prior to disposal on land, to prevent odors, insect and rodent problems, and release of pathogenic organisms to groundwater or to crops.

Sludge Dewatering

Two processes are commonly used to dewater sludges. Small treatment plants usually employ sludge drying beds while larger treatment plants use vacuum filtration or centrifugation. A sludge drying bed relies on evaporation and gravity drainage to dewater sludge. Typical loading rates are on the order of 25 pounds of dry solids per square foot per year. Vacuum filtration involves the filtration of liquid sludge through a porous media under the influence of an applied vacuum. A sludge cake containing twenty to thirty percent solids content and about 1/16 to 1/4 inch thick is deposited on the outside of a rotating drum.

Drying beds offer the advantage of low cost but require large land areas and labor costs. Vacuum filtration requires a small area but costs of construction are higher.

Wet Oxidation

Wet oxidation involves the high temperature, high pressure combustion of volatile matter in a fluid media. The process is carried out at pressures of 1,200 to 1,800 psig and at temperatures greater than 540°F. Wet oxidation may result in a COD reduction of about 80 percent and reduction of volatile solids by approximately 90 percent. Frequently, severe corrosion problems are associated with the process, the residue contains substantial unoxidized organic matter, and a strong recycle liquor is created.

Incineration

Incineration involves the destruction of volatile materials at elevated temperatures. Multiple hearth furnaces are the most popular furnace for sewage sludge incineration. Temperatures range from 800°F on the top hearths to 1,600-1,800°F on the combustion zone, to 500°F on the lower hearths.

Multiple hearth incineration offers the following advantages: simplicity, flexibility to handle fluctuating loads, durability and low maintenance requirements, complete destruction of organic materials, and the ability to burn grit, screenings, scum, and sludge simultaneously. Disadvantages of the process include: high capital costs, and requirement of skilled operation.

Incineration is not a complete disposal method, since ash remains that must be removed and disposed of, typically by landfilling. The ash is inert, and makes good fill material.

In older incinerator installations, sufficient attention was not given to prevention of air pollution by the discharge of combustion products from

the stack. Consequently, incineration has a bad reputation in this regard. However, modern sludge incinerators are fitted with afterburners, pre-cooler, high efficiency scrubbers and steam plume suppression, and are fully capable of meeting the most stringent air pollution control standards. Unlike some fuels, sewage sludge contains little sulfur, and sulfur oxides are not a serious problem from this process.

Sanitary Landfill

Landfills are used for disposal of dried digested sludges. Sludges could be landfilled at a separate site or at the site of the municipal, solid waste, sanitary landfill. In the landfilling of sludges, the sludge is normally placed in shallow trenches and covered with a layer of earth. Landfilling of sludges can be a relatively inexpensive disposal method, especially if the landfilling operation is carried out at the municipal refuse disposal site, but costs of land and transportation are high.

Composting

Composting is a biochemical process which will decompose the organic material contained in refuse to a humus-like material in a sanitary manner. Modern composting features the use of aerobic microorganisms in a rapid, thermophilic decomposition of solid organic material under controlled conditions.

Indications are that most, pathogenic agents are killed during the process, which liberates sufficient heat to produce temperatures of 120°F or higher. The end product has found use as a soil conditioner but has negligible value as a fertilizer. Attempts to fortify compost to convert it to fertilizer have resulted in costs higher than the cost of commercially produced fertilizers. Unlike landfilling or incineration, composting, at least in

theory, offers the following advantages: there is less risk of air or water pollution; a useful (although not saleable) product is produced; and recycling of certain components of refuse, such as metal and paper, may be possible. Materials that might be salvaged include ferrous metals, non-ferrous metals, glass and rags.

Conversion of waste materials to compost is a natural digestion process, in which biological oxidation takes place to stabilize the decomposable organic fractions.

A number of municipal composting plants, as shown in Table IV-12 have been built in this country. Usually developed by private enterprise, the vast majority have failed. In at least two recent instances, municipal officials have forced plants to shut down because of odors and other nuisances. However, failure is most often due to financial difficulty. Primary factors creating financial problems have been 1) the high cost of plant construction and operation, 2) inability to develop a market for the compost, and 3) problems in disposing of the large proportion of non-compostables (plastics, metals, etc.). In addition, since composting plants cannot handle most items of bulky refuse, these must be disposed of by other means.

TABLE IV-12

CURRENT STATUS OF U.S. COMPOSTING PLANTS[a]

Location	Process	Capacity-Tons/Day	Year Built	Year Closed
Altoona, Pa.	Fairfield-Hardy	25	1951	Operating
Springfield, Mass.	Frazer-Eweson	20	1954[b]	1962
Williamston, Mich.	Riker	4	1955	1962
McKeesport, Pa.	Windrow	100	1956	1957
Sacramento, Calif.	Dano	40	1956	1963
Norman, Okla.	Naturizer	40	1959	1964
Phoenix, Arix.	Dano	300	1962	1965
Largo, Fla.	Hardy	50	1963	1968
San Fernando, Calif.	Naturizer	70	1963	1964
Wilmington, Ohio	Windrow	20	1963	1964
Boulder, Colo.	Rasping	100	1965	1968
St. Petersburg, Fla.	IDC[c]	105	1966	1968
Houston, Texas	Metrowaste	330	1966	Operating
Johnson City, Tenn.	Windrow	60	1967	Operating
Gainesville, Fla.	Metrowaste	150	1968	Operating

[a] "A current Review of Composting" by Garret P. Westerhoff, Public Works, November, 1969, Pg. 87, with additions.

[b] Partially burned in 1958, rebuilt in 1961.

[c] Similar to the Naturized system.

Sewage sludge can be composted along with municipal refuse. The sludge would add needed moisture for the composting process and would add some degree of nutrients to the final compost. In order that all sludge could be handled, the sludge would first have to be thickened, perhaps by centrifuging.

Irrigation

Digested sewage sludge can be used as an irrigation water under special circumstances. This would take advantage of the fertilizer value of liquid sludge. Irrigation could be accomplished by spraying or by introducing the

sludge into a ridge and furrow system. Sludge would be stored during the winter months to avoid extreme operational problems. Rates of application typically vary from twenty to 100 dry tons of sludge per acre per year. Digested sludge would be required from aesthetic and public health standpoints.

Spreading Dried Sludge as a Soil Conditioner

Dried sludge can be applied to farmland to take advantage of this fertilizer value. The sludge would be spread on the land and then harrowed or plowed in. If lime was not added to the sludge before vacuum filtration, the field might require liming in the fall before the application of the sludge to regulate soil pH, make the phosphorus of the sludge more available to the soil, and to precipitate heavy metals in the sludge. Digested sludges are necessary for spreading since the digestion process effects a reduction of pathogens, fats and volatiles. Raw sludges are not desirable due to high pathogen and high grease contents. Typical application rates vary from ten to forty dry tons of sludge per acre per year. Best results would result from the use of chemical fertilizers in addition to the dried sludge.

Placement in Underground Cavaties

This disposal method is similar to deep well injection in that it is a long-term storage method. Wastes would be placed in large, geologically isolated, underground cavities and stored indefinitely. Cavities could be mined for the expressed purpose of waste disposal or existing natural cavities or existing abandoned mines might be used. The main disadvantage of mining storage space is that huge volumes of mine spoil must be handled and relocated. Salt cavities and mines lend themselves to sludge storage due to their low permeability and porosity and their "self-sealing" ability. Also, controlled nuclear blasting shows great promise for use in creating

large, underground cavities economically.

Within the study area, no natural cavities of substantial size are known to exist. Due to the high cost of mining such cavities, this method could only be considered for storage of the relatively small volumes of solid or semi-solid residue from industrial waste treatment, or for radioactive wastes.

Abandoned strip mine areas offer possibilities for useful disposal of organic sludges. Pilot tests have shown that strip mine tailings and spoil areas which will not support plant growth can be made suitable for cover crops and woodlands by application of digested sewage sludge in about two years. Such use of sludge would not only reclaim waste land but would reduce erosion and acid drainage, and at the same time dispose of waste sludge.

Strip mine areas are available in southeastern Ohio for this purpose, and one of the strategy plans presented in this study includes disposal of sludge by this method.

Industrial Sludge and Runoff Sludge Handling

Industrial sludges and residues were assumed to be dewatered and placed in underground cavities. The cavities to be used would be excavated specifically for disposal. Where possible, industrial sludges should be processed for recovery and reuse of valuable contaminants. Sludges from the treatment of urban storm runoff would be landfilled within ten miles of the point of discharge or treatment.

5. STORM WATER RUNOFF

Four plans are proposed to collect, treat and dispose of storm water runoff. Some of these plans would also treat sustained dry weather flow in addition to storm runoff.

All of these plans would be designed to give nearly the same degree of treatment. Treatment would consist of pre-treatment, primary sedimentation in storage basins followed by additional physical separation by microstrainers or long term stabilization and oxidation, and disinfection.

Waste load reductions are estimated to be as follows for all plans except for the spreading-percolation basin.

Parameter	Estimated Average Reduction
Total Solids	62%
Suspended Solids	72%
BOD	70%
COD	62%
Total N	50%
Total P	50%

The collection system would be designed to handle the one year storm peak flow.

Total Runoff Treatment

Under this plan, it is proposed to build four offshore stabilization basins in Lake Erie to treat both storm runoff and dry weather flow from the entire tributary area of all watersheds. Basins would be built at the mouths of Rocky River, Cuyahoga River and Chagrin River, and one near Easterly Wastewater Treatment Plant on Cleveland east side.

The collection systems required for these basins would consist of interceptors along Lake Erie shoreline to pick up streams, storm drains and combined sewer overflows now discharging directly into Lake Erie. These interceptors would be force mains with pumping stations and up-system holding basins to

reduce the required capacity of pumps and force mains. In some cases where adequate head is available, the interceptors may be designed as gravity conduits. From the collection point on the shoreline, the flows are carried through subaqueous pipes to the basin. At the mouth of each river a barrier would be required to separate river flows from the lake with provisions for flood overflows and navigation traffic in and out of the river.

The basins would be built about 1,000 to 3,000 feet offshore to minimize conduit cost. Walls would be built of cellular steel sheet piling cofferdams filled with sand or crushed stone. It is proposed that each basin be divided into three zones: an aeration zone, a settling zone and reaeration zone with arrangement for chlorination when required. Partitions between zones may be of the flexible curtain wall type. Each basin would be provided with multiple submerged discharge ports to achieve efficient dispersion of the effluent into the lake waters. The shape of basins would be rectangular to achieve high hydraulic efficiency and low ratio of wall length to basin area, however shape modifications should be considered for each basin to suit local conditions or to provide secondary facilities such as marinas.

Based on 1-year storm and 30-day dry weather flows, the following sizes were computed, including 20% allowance for hydraulic inefficiency and wave displacement.

Basin	Volume
Rocky River	15,000 Acre-Feet
Cuyahoga River	42,000 Acre-Feet
Chagrin River	11,000 Acre-Feet
Miscellaneous Area (East Cleveland)	9,000 Acre-Feet

The advantages of this plan are:

-Runoff flows from the entire tributary areas (urban and rural) are treated.

-Sustained dry weather flows are treated.

-Collection systems cost is minimum since streams and rivers are used to convey flows to the shoreline, and collection systems are required only along the shoreline and from the collection points to basins.

-Cleaner water at beaches is possible since effluent from basins is discharged a substantial distance offshore. Beach activities and boating are enhanced if recreational facilities are incorporated with the planning of basins.

-Objections to treatment sites are minimum.

-Basins can be incorporated into offshore airport using a common wall for cost advantages.

The disadvantages of this plan are:

-Streams and river water quality is not improved.

-Navigation in rivers would be more complicated because of the barriers separating rivers from lake waters. Some sort of a gate or navigation lock might be required.

Discharge - Point Treatment

It is proposed, under the second plan, to collect and treat storm runoff from urban areas, and dry weather flows of some streams which run entirely through urban areas. Runoff from rural areas as well as dry weather flows of rural streams and rivers would not be treated.

Urban areas in each watershed would be divided into several drainage sub-districts. Each sub-district would have an independent collection system and treatment facility at the point where it discharges to the receiving water. This plan would provide a reasonable collection system as to length, size and cost of pipes and the treatment facilities would be of such a size that they could be located at available spaces near urban areas.

The collection system of each sub-district would be interceptors along streams, rivers or the lake shoreline, in order to collect urban runoff

before it discharges into these water bodies. The interceptors would be either gravity conduits, or force mains and pumping stations with holding basins as necessary to reduce peak flows. The collection systems would have to be studied in detail to arrive at the most feasible layout which serves an urban sub-district and deliver flows to the collection point at a suitable site for a stabilization basin or treatment facility.

Stabilization basins for treatment along the lake shoreline may be built offshore and would be of the same design criteria as discussed under the total runoff treatment plan. Onshore treatment facilities would be designed with primary treatment plus storage.

The total volume of water treated on an annual basis would be 12,000 million cubic feet.

The advantages of this plan are:

-The rivers and streams are protected.

-Load inputs to Lake Erie from urban land is reduced.

-Offshore treatment basins are not as large.

-Dry weather flow from urban storm drains and combined sewer overflows are treated.

The disadvantages to this plan are:

-An extensive collection system is required.

Storage and Pump-Back

This plan differs from the discharge point treatment system only with regards to the actual treatment site. Under this plan, treatment would take place in regional wastewater treatment plants. The collection system would be nearly the same, except that storage and pumping stations would be used to reduce pipe sizes from the collection system to the regional treatment plants. In most areas force mains would be used to deliver runoff from the storage sites at the collection point to the treatment plant. Flow to the

treatment plant would be constant during discharge with an emptying period of about three days. Primary treatment would be accomplished at the storage site and additional treatment in form of physical separation would be performed at the treatment plant.

The total volume of water treated on an annual basis would be 12,000 million cubic feet or the same as the discharge point treatment plan.

The advantages to this plan are:

-The existing plants can be used to provide additional treatment and disinfection.

-Along Lake Erie, the plant outfalls can be used to disperse the effluent.

-Since long-term storage is not involved, the final storage basins can be reduced in size.

The disadvantages to this plan are:

-Additional pumping, storage and transmission facilities are needed in some areas to reach the regional treatment plants.

-If the treatment plant is a standard biological plant, the treatment of a low nutrient runoff water and the problems with dilution may affect the efficiency of overall treatment.

Spreading - Percolation

This plan differs from the storage pump-back plan in the treatment phase. The collection system and storage and pumping system would be virtually the same. The transmission system from the storage site would deliver the runoff water to a long-term storage site and a spreading-percolation basin for treatment on land. Storage would be necessary for the winter months. The waste load reduction for this system are estimated at:

Parameters	Estimated Average Reduction
Total Solids	30%
Suspended Solids	90%
BOD	96%
COD	91%
Total N	30%
Total P	10%

The total volume of water to be treated in an annual basin would be 12,000 million cubic feet.

For the one-year storm, the following total area is required:

Storage - 5,600 acres (15' deep)

Spreading-percolation - 1,200 acres

The spreading-percolation basin would have to be constructed since the local soils are not suitable for the necessary application rates.

The advantages of this plan are:

-Greater reduction of suspended solids, BOD and COD.

-Streams and rivers are protected and low flow could be augmented.

The disadvantages of this plan are:

-Increase in land requirements.

-Increase in transmission facilities required.

C. PRESENTATION OF ALTERNATIVES

1. GENERAL

A number of alternatives were considered, and a total of eight were selected for further analysis. These alternatives are listed for identification as follows:

W-1 - Regional System of Advanced Treatment Facilities, Separate Treatment of Runoff. Water Based.

W-2 - Regional System of Advanced Treatment With Combined Treatment of Runoff. Water Based.

L-1 - Aerated Lagoons and Spray Irrigation on Croplands. Land Plan.

L-2 - Oxidation Lagoons and High Rate Percolation from Spreading Basins. Land Based.

C-1 - Secondary Treatment in Regional Plants, Effluent to Spray Irrigation on Croplands. Combination.

C-2 - Secondary Treatment in Regional Plants, Effluent to High Rate Percolation in Spreading Basins. Combination.

C-3 - Inner Ring Region Provided with Water Based Treatment; Outer Ring Region Provided with Land Based Treatment. Combination

C-4 - Inner Ring Region Provided with Water Based Treatment; Outer Ring Region Provided with Combination of Water-Land Based Treatment. Combination.

The basic features of each alternative are presented in summary form in Table IV-13 and Table IV-14 gives the total land requirements of each land disposal alternative. A detailed description of each is given following the table. Cost estimates are given in Section 10 for all alternatives. Table IV-15 explains the method of sludge handling and Table IV-16 compares

the 2020 effluent loads discharged to the Three Rivers Watershed.

Following the description of each alternative, a special discourse is presented for pollution control in the lower Cuyahoga River industrial valley. (Section 11)

In Section 12, a brief listing is given of other processes which were rejected for various reasons.

Efficiencies for the alternatives are shown in Tables IV-1 and IV-2. Also Attachment 3 lists soils in Northeast Ohio and Attachment 4 gives preliminary design criteria.

TABLE IV-13

W-1 - REGIONAL SYSTEM OF ADVANCED TREATMENT FACILITIES

SEPARATE TREATMENT OF RUNOFF

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater
Collection System	Use existing sewer systems to collect to local plant sites. New systems collect to proposed regional plants	Compatible wastes collected with municipal wastes. Non-compatible wastes collected by tank truck or separate pipe system.	New interception and storage systems to collect discharges of combined sewer overflows and urban runoff, along lakefront and rivers.
Transport System	Construct new interceptors, pump stations and force mains to convey flow to regional treatment sites.	Compatible wastes transported with municipal wastewater. Non-compatible transported by tank truck from collection points to treatment sites.	Short force mains or interceptors to convey to new treatment and disposal sites.
Treatment System	Secondary and advanced waste treatment at all centralized treatment plants. Phosphate removal at all plants, nitrogen removal at Akron and Cleveland Southerly. Tertiary coagulation, filtration and disinfection.	Compatible wastes treated with municipal. Non-compatible wastes treated at new facilities at Akron and Cleveland. Rubber industry wastes pre-treated in separate plant.	Storage and pre-treatment by screening. Treatment of flows up to 1-year storm in large stabilization basins in Lake Erie with disinfection before release to Lake, or in separate treatment facilities on land. Excess flows screened and chlorinated before release. Some dry weather flow intercepted and treated with municipal wastes.
Disposal or Re-Use System	Effluents discharged to surface streams or Lake Erie. Some effluents used for recharge in natural percolation areas within district. Part of Southerly effluent recycled as industrial water supply for Cuyahoga valley industries. Sludge disposed of on land or used for land reclamation (if digested), or incinerated (if undigested) with ash used for landfill.	Pre-treated effluents to municipal systems for advanced treatment. Cooling waters reduced in temperature and discharged to receiving waters. Some wastes reclaimed for recycle, such as pickling liquors, reclaimable oils.	Release to receiving waters. Some treated runoff may be recycled to augment flow in lower Cuyahoga and reduce temperature.

W-1

TABLE IV-13 CONT'D.

W-2 - REGIONAL SYSTEM OF ADVANCED TREATMENT WITH COMBINED TREATMENT OF RUNOFF

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater
Collection System	Use existing sewer systems to collect to local plant sites. New systems collect to proposed regional plants.	Compatible wastes collected with municipal wastes. Non-compatible wastes collected by tank truck or separate pipe system.	Interceptor and up-system storage to collect combined sewer overflows and runoff from urban areas. Collect some dry weather flow and up to 1-year storm flows.
Transport System	Construct new interceptors, pump stations and force mains to convey flow to regional treatment sites.	Compatible wastes transported with municipal wastewater. Non-compatible transported by tank truck from collection points to treatment sites.	Force mains or gravity interceptors to on-site storage at major regional treatment plants (Easterly, Southerly, Westerly, Akron)
Treatment System	Secondary and advanced waste treatment at all centralized treatment plants. Phosphate removal at all plants, nitrogen removal at Akron and Cleveland Southerly. Tertiary coagulation, filtration and disinfection.	Compatible wastes treated with municipal. Non-compatible wastes treated at new facilities at Akron and Cleveland. Rubber industry wastes pre-treated in separate plant.	Screening and primary treatment in storage basins prior to pump-back to municipal treatment plant. Effluent disinfection. Excess flows screened and chlorinated before release. Some dry weather flows intercepted and treated with municipal wastes.
Disposal or Re-Use System	Effluents discharged to surface streams or Lake Erie. Some effluents used for recharge in natural percolation areas within district. Part of Southerly effluent recycled as industrial water supply for Cuyahoga valley industries. Sludge disposed of on land or used for land reclamation (if digested), or incinerated (if undigested) with ash used for landfill.	Pre-treated effluents to municipal systems for advanced treatment. Cooling waters reduced in temperature and discharged to receiving waters. Some wastes reclaimed for recycle, such as pickling liquors, reclaimable oils.	Release to receiving waters. Some treated runoff may be recycled to augment flow in lower Cuyahoga and reduce temperature.

TABLE IV-13 CONT'D.

L-1 - AERATED LAGOONS AND SPRAY IRRIGATION ON CROPLANDS

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater
Collection System	Use existing sewer systems to collect wastewater to sites of present wastewater treatment plants. Install new pump stations. Construct future sewers to regional pumping stations along force mains or canals.	Compatible wastes collected with municipal wastewater in sewer system. Toxic and non-compatible wastes collected by tank truck or pipeline to central points.	Runoff collected by new storm water interceptors along lakefront and Cuyahoga River in Cleveland and other rivers and streams in the rest of the area.
Transport System	Combination of pump stations, force mains and gravity channels to winter storage basins and treatment sites. Winter storage for 22 weeks/year.	Compatible wastes transported with municipal wastewater. Non-compatible wastes - combination of tank truck and pipeline to disposal sites.	Lift stations and open channels to land disposal sites.
Treatment System	Coarse screening, aerated lagoon treatment, spray irrigation to underdrained croplands without special nutrient removal. Total land requirement 348.2 sq.mi.	Compatible wastes treated with municipal. Non-compatible wastes concentrated by chemical-physical treatment for underground disposal.	Discharge to spreading basins constructed of permeable materials for high percolation rates.
Disposal or Re-Use System	Effluent from underdrains returned to surface streams within the Three Rivers area to maintain stream flow. Some loss to ground water aquifers outside of basin. Sludge disposed of on spray irrigation land.	Pumped to underground cavities, created by mining or by atomic explosion, or to deep well injection for permanent storage.	Percolate collected by underdrains and pumped to surface streams or stream recharge basins. Suitable for re-use as raw water supply.

L-1

TABLE IV-13CONT'D.

L-2 - AERATED LAGOONS AND HIGH RATE PERCOLATION FROM SPREADING BASINS

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater
Collection System	Use existing sewer systems to collect wastewater to sites of present wastewater treatment plant. Install new pumping stations. Construct new sewers to regional pumping stations along transport force mains or canals.	Compatible wastes collected with municipal wastewater in sewer system. Toxic and non-compatible wastes collected by tank truck or pipeline to central points.	Runoff collected by new storm water interceptors along lakefront and Cuyahoga River in Cleveland and other rivers and streams in the rest of the area.
Transport System	Combination of pumping stations, force mains and gravity channels to storage basins and treatment sites. Winter storage for 12 weeks/year.	Compatible wastes with municipal. Non-compatible wastes - combination of tank truck and pipeline to disposal sites.	Lift stations and open channels to convey to land disposal sites.
Treatment System	Coarse screening; aerated lagoon treatment; application to 12' deep spreading basins constructed of permeable materials for high rate percolation; underdrainage pumped to nutrient removal by chemical-physical means. (12"/day application rate). Total land requirement 25.6 sq.mi.	Compatible wastes treated with municipal. Non-compatible wastes concentrated by chemical-physical treatment for underground disposal.	Discharge to spreading basins constructed of permeable materials for high percolation rates.
Disposal or Re-Use System	Effluent from underdrains returned to surface streams within the Three Rivers area to maintain stream flow. Digested sludge disposed of on land. Sludges from nutrient removal applied to land as fertilizers or transported for wasteland reclamation.	Pumped to underground cavities, created by mining or by atomic explosion, or to deep well injection for permanent storage.	Percolate collected by underdrains and pumped to surface streams or stream recharge basins. Suitable for re-use as raw water supply.

L-2

TABLE IV-13 CONT'D.

C-1 - SECONDARY TREATMENT IN REGIONAL PLANTS, EFFLUENT TO SPRAY IRRIGATION ON CROPLANDS

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater[1]
Collection System	Use existing sewer system to collect to local plant sites. New systems collect to proposed regional plants.	Compatible wastes collected with municipal wastes. Non-compatible wastes collected by tank truck or separate pipe system.	New interception and storage systems to collect discharges of combined sewer overflows and urban runoff, along lakefront and rivers.
Transport System	Construct new interceptors, pump stations and force mains to convey flow to regional treatment sites. New pump station and force mains to convey plant effluents to storage and treatment on land.	Compatible wastes transported with municipal wastewater. Non-compatible transported by tank truck from collection points to treatment sites.	Short force mains or interceptors to convey to new treatment and disposal sites.
Treatment System	Secondary treatment at all regional treatment plants. Winter storage for 22 wks/yr. Partial nutrient removal only. Secondary effluent to remote land sites for tertiary treatment by spray irrigation to underdrained croplands or woodlands without nutrient removal from underdrainage. Total land 346.5 sq.mi.	Compatible wastes treated with municipal. Non-compatible wastes treated at new facilities at Akron and Cleveland. Rubber industry wastes pre-treated or collected and treated in a separate plant.	Storage and pre-treatment by screening. Treatment of flows up to 1-year storm in large stabilization basins in Lake Erie with disinfection before release to Lake, or in separate treatment facilities on land. Excess flows screened and chlorinated before release. Some dry weather flow intercepted and treated with municipal wastes.
Disposal or Re-Use System	Effluent from underdrains returned to surface streams within the Three Rivers area to maintain stream flow. Some loss to ground water aquifers outside of basin. Sludge disposed of on land or used for land reclamation (if digested), or incinerated (if undigested), with ash used for landfill.	Pre-treated effluents to municipal systems for advanced treatment. Cooling waters reduced in temperature and discharged to receiving waters. Some wastes reclaimed for recycle, such as pickling liquors, reclaimable oils.	Release to receiving waters. Some treated runoff may be recycled to augment flow in lower Cuyahoga and reduce temperature.

C-1

[1] Treatment of runoff wastewaters under this alternative is similar to that stipulated for W-1. A variation of C-1 could handle runoff in the same manner stipulated for W-2.

TABLE IV-13 CONT'D.

C-2 - SECONDARY TREATMENT IN REGIONAL PLANTS,

EFFLUENT TO HIGH RATE PERCOLATION IN SPREADING BASINS

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater[1]
Collection System	Use existing sewer system to collect to local plant sites. New systems collect to proposed regional plants.	Compatible wastes collected with municipal wastes. Non-compatible wastes collected by tank truck or separate pipe system.	New interception and storage systems to collect discharges of combined sewer overflows and urban runoff, along lakefront and rivers.
Transport System	Construct new interceptors, pump stations and force mains to convey flow to regional treatment sites. New pump station and force mains to convey plant effluent to storage and treatment on land.	Compatible wastes transported with municipal wastewater. Non-compatible transported by tank truck from collection points to treatment sites.	Short force mains or interceptors to convey to new treatment and disposal sites.
Treatment System	Secondary treatment at all regional treatment plants including nutrient removal. Winter storage for 12 weeks/year. Secondary effluent to remote land sites for tertiary treatment in spreading basins by high rate percolation, without nutrient removal from underdrainage. Total land 23.9 sq.mi..	Compatible wastes treated with municipal. Non-compatible wastes treated at new facilities at Akron and Cleveland. Rubber industry wastes pre-treated or collected and treated in a separate plant.	Storage and pre-treatment by screening. Treatment of flows up to 1-year storm in large stabilization basins in Lake Erie with disinfection before release to Lake, or in separate treatment facilities on land. Excess flows screened and chlorinated before release. Some dry weather flow intercepted and treated with municipal wastes.
Disposal or Re-Use System	Effluent from underdrains returned to surface streams within the Three Rivers area to maintain stream flow. Some loss to ground water aquifers outside of basin. All sludge digested and transported to strip mine areas for land reclamation.	Pre-treated effluents to municipal systems for advanced treatment. Cooling waters reduced in temperature and discharged to receiving waters. Some wastes reclaimed for recycle, such as pickling liquors, reclaimable oils.	Release to receiving waters. Some treated runoff may be recycled to augment flow in lower Cuyahoga and reduce temperature.

C-2

[1] Treatment of runoff wastewaters under this alternative is similar to that stipulated for W-1. A variation of C-2 could handle runoff in the same manner stipulated for W-2.

TABLE IV-13 CONT'D.

C-3 - INNER RING REGION PROVIDED WITH WATER BASED TREATMENT;
OUTER RING REGION PROVIDED WITH LAND BASED TREATMENT[1]

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater[2]
Collection System	Use existing sewer system to collect to regional plant sites, both Rings.	Compatible wastes collected with municipal wastes. Non-compatible wastes collected by tank truck or separate pipe system.	Short force mains or interceptors to convey to new treatment and disposal sites.
Transport System	Inner Ring: Construct new interceptors, pump stations and force mains to convey flow to regional treatment sites. Outer Ring: Combination of pump stations, force mains and gravity channels to storage and treatment sites. Winter storage for 22 weeks/year.	Compatible wastes transported with municipal wastewater. Non-compatible transported by tank truck from collection points to treatment sites.	Short force mains or interceptors to convey to new treatment and disposal sites.
Treatment System	Inner Ring: Secondary and advanced waste treatment at all inner ring regional plants. Phosphate removal at all plants, nitrogen removal at Cleveland Southerly. Tertiary coagulation, filtration and disinfection. Outer Ring: Coarse screening, aerated lagoon treatment, spray irrigation to underdrained croplands without special nutrient removal from underdrainage. Total land 96.9 square miles.	Inner and Outer Rings: Compatible wastes treated with municipal. Non-compatible wastes treated at new facilities at Akron and Cleveland. Rubber industry wastes pre-treated in separate plant.	Storage and pre-treatment by screening. Treatment of flows up to 1-year storm in large stabilization basins in Lake Erie with disinfection before release to Lake, or in separate treatment facilities on land. Excess flows screened and chlorinated before release. Some dry weather flow intercepted and treated with municipal wastes.

TABLE IV-13 CONT'D.

C-3 CONT'D.

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater[2]
Disposal or Re-Use System	Inner Ring: Effluents discharged to surface streams or Lake Erie. Some effluents used for recharge in natural percolation areas within district. Part of Southerly effluent recycled industrial water supply for Cuyahoga valley industries. Sludge disposed of on land or used for land reclamation (if digested), or incinerated (if undigested) with ash used for landfill. Outer Ring: Effluent from underdrains returned to surface streams within the Three Rivers area to maintain stream flow. Some loss to ground water aquifers outside of basin. Sludge applied to spray irrigation sites.	Inner and Outer Rings: Pretreated effluents to municipal systems for advanced treatment. Cooling waters reduced in temperature and discharged to receiving waters. Some wastes reclaimed for recycle, such as pickling liquors, reclaimable oils.	Inner and Outer Rings: Release to receiving waters. Some treated runoff may be recycled to augment flow in lower Cuyahoga and reduce temperature.

(1) Inner Ring includes Cleveland and environs, approximately north of Cuyahoga County - Medina County line; Outer Ring includes Akron, Medina, Kent and Ravenna regions.

(2) Treatment of runoff wastewaters under this alternative is similar to that stipulated for W-1. A variation of C-3 could handle runoff in the same manner stipulated for W-2.

TABLE IV-13 CONT'D.

C-4 - INNER RING REGION PROVIDED WITH WATER BASED TREATMENT;
OUTER RING REGION PROVIDED WITH COMBINATION OF WATER-LAND BASED TREATMENT[1]

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater[2]
Collection System	Use existing sewer system to collect to regional plant sites, both Rings.	Inner and Outer Rings: Compatible wastes collected with municipal wastes. Non-compatible wastes collected by tank truck or separate pipe system.	Inner and Outer Rings: New interception and storage systems to collect discharges of combined sewer overflows and urban runoff, along lakefront and rivers.
Transport System	Inner Ring: Construct new interceptors, pump stations and force mains to convey flow to regional treatment sites. Outer Ring: New interceptors, pump stations and force mains to convey flow to regional treatment sites. New pump station and force mains to convey plant effluents to storage and treatment on land. Winter storage for 22 weeks/year.	Inner and Outer Rings: Compatible wastes transported with municipal wastewater. Non-compatible transported by tank truck from collection points to treatment sites.	Inner and Outer Rings: Short force mains or interceptors to convey to new treatment and disposal sites.
Treatment System	Inner Ring: Secondary and advanced waste treatment at all inner ring regional plants. Phosphate removal at all plants, nitrogen removal at Cleveland Southerly. Tertiary coagulation, filtration and disinfection. Outer Ring: Secondary treatment at all regional treatment plants. Partial nutrient removal only. Secondary effluent to remote land sites for tertiary treatment by spray irrigation to underdrained croplands or woodlands. without special nutrient removal from underdrainage. Total land 96.4 sq.mi.	Inner and Outer Rings: Compatible wastes treated with municipal. Non-compatible wastes treated at new facilities at Akron and Cleveland. Rubber industry wastes pre-treated in separate plant.	Inner and Outer Rings: Storage and pre-treatment by screening. Treatment of flows up to 1-year storm in large stabilization basins in Lake Erie with disinfection before release to Lake, or in separate treatment facilities on land. Excess flows screened and chlorinated before release. Some dry weather flow intercepted and treated with municipal wastes.

C-4

TABLE IV-13 CONT'D.

C-4 CONT'D.

	Municipal Wastewater	Industrial Wastewater	Runoff Wastewater[2]
Disposal or Re-Use System	Inner Ring: Effluents discharged to surface streams or Lake Erie. Some effluents used for recharge in natural percolation areas within district. Part of Southerly effluent recycled industrial water supply for Cuyahoga valley industries. Sludge disposed of on land or used for land reclamation (if digested), or incinerated (if undigested) with ash used for landfill. Outer Ring: Effluent from underdrains returned to surface streams within the Three Rivers area to maintain stream flow. Some loss to ground water aquifers outside of basin. Sludge disposed of on land or used for land reclamation (if digested), or incinerated (if undigested), with ash used for landfill.	Inner and Outer Rings: Pretreated effluents to municipal systems for advanced treatment. Cooling waters reduced in temperature and discharged to receiving waters. Some wastes reclaimed for recycle, such as pickling liquors, reclaimable oils.	Inner and Outer Rings: Release to receiving waters. Some treated runoff may be recycled to augment flow in lower Cuyahoga and reduce temperature.

(1) Inner Ring includes Cleveland and environs, approximately north of Cuyahoga County - Medina County line; Outer Ring includes Akron, Medina, Kent and Ravenna regions.

(2) Treatment of runoff wastewater under this alternative is similar to that of W-1. A variation of C-4 could handle runoff in the same manner stipulated for W-2.

TABLE IV-14

SUMMARY OF LAND REQUIREMENTS YEAR 2020

	Land for Storage Basins Sq.Mi.	Land for Aerated Lagoons Sq.Mi.	Land for Spray Irrig. Sq.Mi.	Land for Spreading Basins Sq.Mi.	Total Sq.Mi.
L-1	34.5	1.7	312	-	348.2
L-2	18.3	1.7	-	5.6	25.6
C-1	34.5	-	312	-	346.5
C-2	18.3	-	-	5.6	23.9
C-3 (Outer Ring)	9.4	0.5	87	-	96.9
C-4 (Outer Ring)	9.4	-	87	-	96.4

|

TABLE IV-15

SLUDGE HANDLING AND DISPOSAL

	Domestic Waste Sludge		Industrial Sludge	
	2020 Quantity	Disposal	2020 Quantity	Dispo
W-1	395 ton/day of incinerator ash	Sludge from large treatment plants incinerated with ash disposal of by landfill -	144 ton/day	Disposal i underground or reclaim
	259,000 gpd of digested sludge	Sludge from small plants digested and spread on land -		
W-2	395 ton/day of incinerator residue	Incinerator ash landfilled -	144 ton/day	Disposal i undergroun or reclaim
	259,000 gpd of digested sludge	Digested sludge spread on land for reclamation.		
L-1		Organic sludge is either oxidized in aerated lagoons or irrigated by spray irrigation along with effluent -	144 ton/day	Disposal i undergroun or reclaim
L-2		Organic sludge is oxidized in aerated lagoons - any resulting sludge will be disposed of locally -	144 ton/day	Disposal i undergroun or reclaim
	185 ton/day of sludge from PO_4 removal	Sludge from PO_4 removal landfilled		
C-1	200 ton/day of incinerator ash	Incinerator ash landfilled -	144 ton/day	Disposal i undergroun or reclaim
	180,000 gpd of digested sludge	Digested sludge spread on land for land reclamation.		
C-2	567 ton/day of digested sludge	Digested sludge pumped to Southeast Ohio for reclamation of strip mined areas.	144 ton/day	Disposal i undergroun or reclaim
C-3	285 ton/day of incinerator ash*	Incinerator ash disposed of by landfill -	144 ton/day	Disposal i undergroun or reclaim
	188,000 gpd of digested sludge*	Digested sludge from small plants spread on land -		
		Organic sludge from aerated lagoons oxidized during treatment or irrigated along with effluent -		
C-4	383 ton/day of incinerator ash	Incinerator ash disposed of by landfilling -	144 ton/day	Disposal i undergroun or reclaim
	251,000 gpd of digested sludge	Digested sludge spread on land for reclamation -		

*inner ring plants only.

TABLE IV-15

HANDLING AND DISPOSAL

2

Industrial Sludge		Runoff Sludge	
2020 ntity	Disposal	2020 Quantity	Disposal
ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge disposed of by land-filling - locally, i.e., within 10 miles of discharge point or treatment site.
ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge to be landfilled - Same as W-1.
ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge to be landfilled - Same as W-1.
4 ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge to be landfilled - Same as W-1.
4 ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge to be landfilled - Same as W-1.
4 ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge to be landfilled - Same as W-1.
4 ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge to be landfilled - Same as W-1.
4 ton/day	Disposal in isolated underground cavities, or reclaimed.	9,090 ton/year	Sludge to be landfilled - Same as W-1.

TABLE IV-16

EFFLUENT LOAD IN 2020 FROM MUNICIPAL AND INDUSTRIAL WASTEWATERS

		LOADS (lb/day)					
Alter-native	Flow (MGD)	BOD	Suspended Solids	Chlorides	Total N	Phosphates as PO_4	Sulfates
W-1	776.9[a.]	28,800	23,000	779,200	10,800	10,200	664,100
W-2	776.9[a.]	28,800	23,000	779,200	10,800	10,200	664,100
L-1	1,144.6[b.]	19,200	34,600	865,700	22,400	80,000	737,900
L-2	974.3[c.]	38,500	69,000	865,700	66,400	10,300	737,900
C-1	1,144.6[b.]	19,200	34,600	865,700	22,400	71,800	737,900
C-2	974.3[c.]	38,500	69,000	865,700	66,400	10,300	737,900
C-3	882.2[d.]	25,900	26,500	805,400	14,400	26,700	685,400
C-4	882.2[d.]	25,900	26,500	805,400	14.400	24,900	685,400

Notes:

a. Year Round
b. For 30 Weeks - No Return During Remaining 22 Weeks of the Year
c. For 40 Weeks - No Return During Remaining 12 Weeks of the Year
d. For 30 Weeks - For Remaining 22 Weeks of the Year Flow is 554.4 MGD

2. ALTERNATIVE W-1 - REGIONAL SYSTEM OF ADVANCED TREATMENT FACILITIES, SEPARATE TREATMENT OF RUNOFF

This system would treat and discharge all municipal and industrial wastes into a receiving water, eventually emptying into Lake Erie. The plan resembles the Northeast Ohio Water Development Plan with respect to the location of the treatment plants and the systems of collection. With this alternative, treatment is to the best of available technology which will result in additional BOD, COD, and solids removal. The system includes the consolidation of more than 120 major treatment plants and several hundred small plants into 28 coordinated regional systems. This system is shown on Figure IV-1.

Municipal wastes will be collected through the existing sewer system and transported to treatment plant sites. Construction of new interceptors, pumping stations and force mains are needed to convey the flow to the regional treatment system. Outfalls would be used to disperse the effluent to the lake for the shoreland plants. Advanced waste treatment will be accomplished at all regional sites with wastewater being treated to affect 95-98% BOD and suspended solids removals or to the best of available technology. Phosphate will be removed at all plants, with nitrogen removal at Cleveland Southerly and the Akron Wastewater Treatment Plant.

A small percentage of wastewater could be used to recharge the ground water aquifers within each watershed. A portion of Southerly effluent will be recycled as industrial water for Cuyahoga Valley industries. Sludges resulting from large municipal operations will be dewatered, incinerated, and then landfilled. Sludge from small plants will be digested and spread on the land. Compatible industrial wastes will be treated with municipal wastes while noncompatible wastes will be handled and treated as previously discussed in Chapter IV. Segregated industrial wastes, besides being treated separately, will be earmarked for reuse wherever possible. For this new treatment emphasis,

new facilities will be constructed at Cleveland and Akron.

In order to prevent thermal pollution from the discharge of hot effluents, cooling towers will be utilized.

This type of treatment alternative offers the advantage of using developed technology. Also, existing treatment facilities could be used in many cases. Wastewater treatment systems are capable of fairly high degrees of treatment. Materials that are partially refractory to the treatment system, especially heavy metals and dissolved solids, may represent significant pollutional loads and the impact of these materials on the environment must be evaluated. Pre-treatment of industrial wastes may increase the overall efficiencies of municipal wastewater treatment due to the removal of materials deleterious to biological treatment.

Storm water will be treated at the point of discharge as previously discussed in Section B-5 of Part IV. Treatment of urban storm runoff is anticipated to reduce pollutional loads to the watercourses within the study area.

This type of water based treatment system is very flexible, especially if storage facilities are provided. Unit processes can be added or subtracted from the system fairly easily and the plant loading can be varied. Storage adds both flexibility and reliability in the event of plant malfunction or overload. Larger treatment plants are more reliable than smaller plants due to improved operation and control. Of course, in the event of prolonged shutdown of large treatment plants, there can be extreme adverse effects on the receiving stream. Reliability of treatment plants is greatly improved by the installation of auxiliary power and standby facilities, as is commonly done at large plants.

Implementation of this and similar water based alternatives, would be hastened by new institutional arrangements. There is a definite need for

authorities having a wide scope of influence. It would appear that W-1 could be fully implemented by the year 2000.

The biggest institutional problem is the funding of interceptor sewers and the purchase of outstanding bond indebtedness of treatment plants which will be phased out. Also, political problems arise due to the outlying areas' fear of control by the central city.

3. ALTERNATIVE W-2 - REGIONAL SYSTEM OF ADVANCE TREATMENT WITH COMBINED TREATMENT OF RUNOFF

This alternative is the same as W-1 except for the treatment of urban runoff. Urban runoff would be treated by the storage and pump-back plan discussed in B-5, Part IV. This is shown on Figure IV-2.

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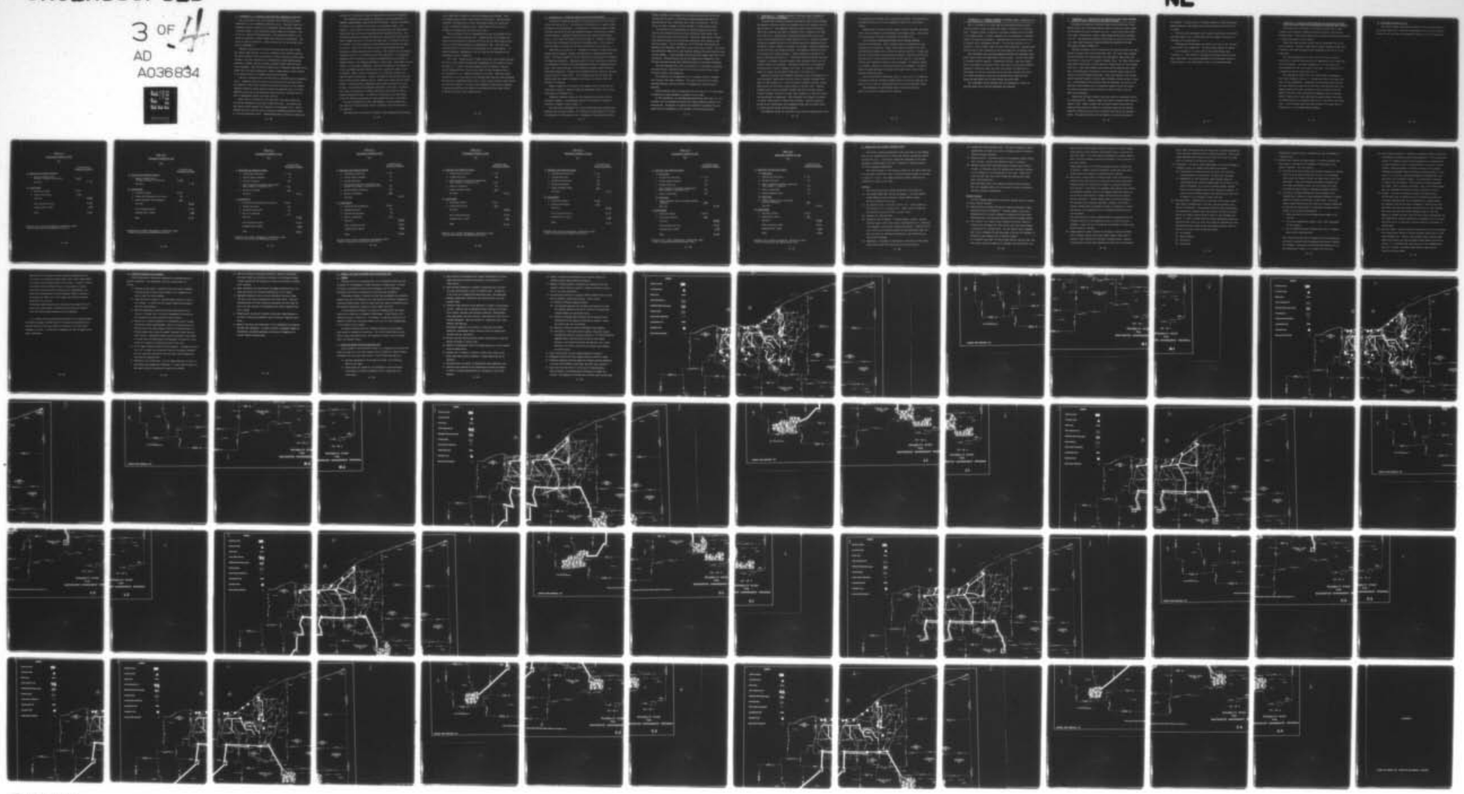

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4. ALTERNATIVE L-1 - OXIDATION LAGOON AND SPRAY IRRIGATION OF CROPLANDS

This system would involve land treatment of all municipal and runoff wastewaters as well as compatible industrial wastes. Municipal wastes and compatible industrial wastes will be pretreated, given secondary treatment in aerated lagoons, stored and used for spray irrigation of cropland. Runoff water is applied to spreading basins. The percolated effluent is collected and returned to surface streams within the Lake Erie Watershed. This system is shown on Figure IV-3. Design criteria for the land systems can be found in Attachment 4.

Municipal wastes would be collected utilizing existing sewer systems. New regional pump stations, as well as interceptor sewers would be required. The actual treatment itself would consist of coarse screening, aerated lagoon treatment, and spray irrigation to an underdrained cropland outside of the watershed. Effluent would be returned to surface streams within the Three Rivers watershed. Some loss must be expected due to percolant penetration of the ground water and evapo-transpiration. Organic sludge would be either oxidized in the aerated lagoons or irrigated along with the effluent.

Industrial wastewater must be sub-divided into compatible and non-compatible wastes. Compatible industrial wastes can be collected with municipal wastes. Non-compatible wastes would be handled as previously discussed in this chapter. Compatible industrial wastes would be treated with municipal waste, while non-compatible wastes can be concentrated by chemical-physical treatment for disposal in underground caverns or man-made cavities.

Runoff would be collected by a new storm water interceptor along Lake Erie and the Cuyahoga River and other streams and rivers. Lift stations and open channels would transport the wastewater to land disposal sites. Highly permeable materials would be used in constructing spreading-percolation basins to yield high percolation rates. Underdraining would be installed to permit the

percolant to be returned to surface streams within the Lake Erie watershed.

This treatment system offers the advantage of utilizing wastewater to produce a useful product--crops which can be harbested. However, the question of whether or not a market for the crops can be developed remains to be answered. Spray irrigation would involve large land areas and large capital expenditures for entirely new transportation and treatment facilities. The system does produce an increased flow during the summer months which could be used to augment the flow in rivers in the study area. Of course, the flow is not returned to the basin during the winter months which would have an impact on the area. About 15% of the water is lost to evapo-transpiration and groundwater recharge and would not be returned. This could be an institutional constraint since it is not returned to the Great Lakes Basin. The mechanical equipment used in the system is relatively uncomplicated and not subject to frequent failure. The treatment efficiency is fairly high. Some metals are also removed. Oil and grease, phosphorus, and dissolved solids are not removed to a very high degree and these materials may have a significant impact on the environment. Under a system of irrigation, it is required to harvest the crops to remove the nutrients. Further, the kinds of crops should be the type that are nearly totally removed; that is, unlike corn in which only the edible portion is removed leaving a substantial root system and possibly the stock portion. The possibility of groundwater pollution is very real. Irrigation also offers the advantage of creating "green space" which could be used to separate metropolitan areas. In addition, the possible use of the storage basins for thermal cooling ponds for nuclear power facilities is available.

The upper Cuyahoga River, above Lake Rockwell, is spray irrigated on land close to the existing plants since a collection system for this area is not economical.

Land based plans are relatively flexible in that additional unit processes

can be added after irrigation as long as underdrains are provided. Also, the storage basins provide a large measure of flexibility. Extreme weather conditions, prolonged frost or rain, could greatly reduce the reliability of such a wastewater treatment system. Deep plowing of the soil can be performed to lengthen the life of the soil filter.

The most difficult facet of implementing this plan will probably be the purchase of the large irrigation sites. Implementation would probably proceed by first constructing irrigation facilities for the "Outer Ring" according to C-4 which could, perhaps, be accomplished by 1980. This would then be phased into C-3 by 1990 with the construction of the needed lagoons. L-1 could be completely implemented by the year 2000 when the remainder of the interceptor system is completed.

Land based systems present a number of difficult institutional problems. The first is that current institutional arrangements are not capable of bringing about L-1. A very, wide scope authority would be required. Problems will be encountered due to the fact that water is being transported out of the watershed and not completely returned to the basin. There also exists a question as to the allocation of the returned water among the three watersheds. The necessity of purchasing large tracts of land in other political sub-divisions will also pose problems. Of course, this irrigation system could be expanded to serve areas outside of the study area and especially those areas close to or passed on the way to the irrigation site.

5. ALTERNATIVE L-2 - OXIDATION LAGOONS AND HIGH RATE PERCOLATION

Collection of municipal wastewater will be carried out with the existing system, the same as in L-1. The effluent is then aerated in a lagoon, stored and applied to spreading basins. The percolant is collected by means of under-draining, treated for nitrate and phosphorus removal, and returned to streams in the watershed. Compatible industrial wastes are treated with municipal wastes. Toxic wastes are handled the same as under L-1. Runoff is collected by storm water interceptors and applied to spreading basins. This system is shown on Figure IV-4 except for the runoff system which is the same as L-1.

Collection is the same as L-1. Treatment will consist of coarse screening, aerated lagoon treatment, storage, and application to spreading-percolation basins. The basins themselves will be constructed of highly permeable materials for high rate percolation. Application rates of twelve inches/day are expected, with underdrain collection for nutrient (phosphate) removal by chemical-physical means. This treated effluent is then returned to surface streams within the Three Rivers Watershed. Nitrates are not removed from this system nor are most dissolved solids or heavy metals. These parameters may have an impact and perhaps would need removal by adding a unit process at the point where the percolant is collected.

Organic sludge will be oxidized in the lagoons or will be used for soil stabilization locally. Chemical sludge from phosphorus removal will be land-filled near the treatment site.

Compatible industrial wastes will be transported and treated with the municipal wastewater. Non-compatible wastes will be handled as previously discussed in Chapter IV and as under L-1.

New storm water interceptors will collect runoff along the lakefront and Cuyahoga River and other streams. Lift stations and open channels will convey the wastewater to land disposal sites. Discharging to spreading basins after

primary treatment at the storage site as previously discussed, will be the treatment for the runoff. Constructed of highly permeable materials for high percolation rates, underdrains must collect the percolant. This percolant can either be pumped to surface streams or stream recharge basins.

This system has the disadvantages of requiring completely new transportation and treatment facilities and the associated large capital costs. Also, large land areas would be required. During the summer months increased flows would be returned to the basin while during the winter months no flow would be returned. In this alternative, all of the water could possibly be returned to the watershed, since there is very little loss to crops. This treatment alternative offers fairly good treatment efficiency but with relatively poor nutrient removal. A large treatment plant for nutrient removal would have to be constructed. Dissolved solids, and oil and grease may be refractory to the treatment processes and may have significant imports on the water environment.

The upper Cuyahoga River, above Lake Rockwell, is discharged to spreading percolation basins constructed close to the collection points since a major collection system is not economical.

The reliability of spreading basins as a treatment process is somewhat less efficient than spray irrigation. This type of system will not remove dissolved materials and may be subject to clogging after several years of operation.

Similar problems would be encountered with this plan as in L-1 with regards to aquisition of land although the acreage is not as large.

In this alternative, the spreading-percolation basin would have to be constructed, that is excavated and filled with a media capable of passing 12" of water per day. The material is probably not available in Northeast Ohio and would have to be transported to the treatment site from outside areas.

6. ALTERNATIVE C-1 - SECONDARY TREATMENT IN REGIONAL PLANTS, EFFLUENT TO SPRAY IRRIGATION ON CROPLANDS

Existing sewer systems and proposed interceptors would collect municipal and compatible industrial wastes and transport them to the regional sites the same as under W-1. Non-compatible industrial wastes would be collected by tank truck or pipeline and taken to treatment sites or treated at the industrial plant site. Combined sewer overflows and urban runoff would be collected by new interception and storage systems as in W-1. Secondary treatment and partial phosphate removal will be effected before the combined municipal wastewater is spray irrigated to croplands or woodlands. Additional phosphates will be utilized in the irrigation system. Non-compatible industrial wastes are collected and treated separately. Runoff wastewater is treated at the point of discharge the same as W-1. Treated and collected effluent from spray irrigation is returned to surface streams, while industrial wastes (oil and pickling liquors) are reclaimed. Chlorinated runoff water is discharged to receiving waters or used to augment river flows. This system is shown in Figure IV-5 except for the runoff system which is the same as W-1.

Municipal wastewater and compatible industrial wastes are transported via new interceptors, pump stations and force mains to regional treatment sites under the same system as W-1. From the regional treatment locations, further pump stations and force mains convey effluent to tertiary sites. Regional treatment plants provide secondary treatment and partial nutrient removal. Tertiary treatment consists of storage, spray irrigation at crops and collecting the percolant in underdrains. Once collected, the effluent is returned to surface stream within the Three Rivers watershed. Digested sludge can be used as soil conditioner, while undigested sludge from the larger plants is incinerated and the ash used for landfill.

Non-compatible wastes are collected by tank truck or separate pipe system

and transported to treatment sites as previously discussed. New facilities in Cleveland and Akron will treat non-compatible, such as oil and pickling liquors.

Combined sewer overflows and urban runoff along the lakefront and various rivers, will be handled by new interceptors and storage systems. Storm water will be treated at the point of discharge as discussed in W-1.

This alternative would partially make use of existing treatment facilities and technology. Spray irrigation offers the advantage of using wastewater for an useful end. Again, water would be returned to the basin only during warm weather with no return flow during the winter. A large land area and a large amount of piping would be required. While the overall treatment efficiency is good, dissolved solids are not removed to a high degree which may have detrimental effects on the environment. The question remains as to whether a market for the produced crops can be developed. Irrigation offers the added advantage of creating "green-space" which could be used to separate metropolitan areas.

One of the problems of phosphorus removal in this plant is in balancing the removal during the secondary treatment process to provide enough for the crops yet not so much that breakthrough will occur to an undesirable amount.

This alternative is more flexible than L-1 since the existing plants can be used for additional unit processes.

7. ALTERNATIVE C-2 - SECONDARY TREATMENT IN REGIONAL PLANTS. EFFLUENT TO HIGH RATE PERCOLATION IN SPREADING BASINS

This is the same as C-1 except high rate spreading-percolation basins are used instead of spray irrigation and sludge is disposed of in strip mine areas. Phosphate removal in addition to secondary treatment will be included at all regional plants. Tertiary treatment will be accomplished in spreading basins, with high rate percolation. Underdraining will be carried out so as to minimize loss to groundwater aquifers. The collected effluent will be returned to surface streams within the Three Rivers Watershed. Digested sludge would be used in land reclamation in the strip mined areas of Southeast Ohio.

This alternative uses existing treatment facilities and technology. Phosphorus removal would be accomplished at existing plants. A fairly high degree of treatment would be expected. Disadvantages include: large land requirements, poor removal of dissolved solids, heavy metals, and nitrogen compounds. Treatment of industrial wastes and urban storm runoff will definitely be advantageous to both the environment and the municipal treatment facilities. As in other alternatives, water will be returned to the study area only during the warm months with no return during the winter weeks.

This alternative is more flexible than its counterpart L-2 since the existing plants can be used for additional unit processes.

8. ALTERNATIVE C-3 - INNER RING REGION PROVIDED WITH WATER BASED TREATMENT; OUTER RING REGION PROVIDED WITH LAND BASED TREATMENT

Municipal and compatible industrial wastes from outlying areas, Akron, Medina, Mantua, Kent and Ravenna regions, would be treated in aerated lagoons and distributed for spray irrigation as in L-1. Similar wastes from "inner ring" areas, Cleveland and vicinity, would undergo advanced waste treatment as in W-1. Non-compatible industrial wastes would be treated in new facilities, while runoff wastewater would be treated and returned to the Lake. This system is shown on Figure IV-7.

Municipal wastewater would be collected by the existing system, and transported to regional plant sites within both rings. The "inner ring" transport system would entail the construction of new interceptors, pump station and force mains to convey flow to regional treatment sites. The "outer ring" system would require force mains to convey wastes to storage facilities and treatment facilities. Inner Ring treatment plants would provide advanced waste treatment. Microstraining or filtration as well as nutrient removal would be effected at all these regional operations. Outer ring treatment would include coarse screening followed by aerated lagoon treatment storage and spray irrigation. Underdraining of the irrigation beds and subsequent collection of the percolant, would minimize loss to groundwater aquifers outside the region. The collected percolant would be returned to surface streams within the Three Rivers Watershed.

Sludge from the large treatment facilities would be incinerated with the ash being landfilled. Digested sludges from smaller treatment plants would be spread on land. Organic sludges from the aerated lagoons would either be oxidized during aeration or applied to irrigation along with the effluent. Compatible industrial wastes can be transported and treated with municipal wastes. Non-compatible wastes will be handled as previously discussed in

this chapter. Cooling waters will undergo treatment to reduce temperature before discharge. Some wastes such as pickling liquors and oils will be reclaimed.

Force mains and interceptors will transport runoff water to new treatment and disposal sites. Runoff wastes will be treated at the point of discharge as discussed under W-1.

Advantages and disadvantages are similar to W-1 and L-1 for the inner ring and outer ring respectively. The land acreage required is smaller.

In the phasing to L-1, this could be the second interim stage following C-4. After the outer ring plants have become obsolete or need major improvement, they could be abandoned and the wastewater treated in aerated lagoons. This could possibly occur in the decade 1990-2000.

9. ALTERNATIVE C-4 INNER RING REGION PROVIDED WITH WATER BASED TREATMENT; OUTER RING REGION PROVIDED WITH COMBINATION OF WATER-LAND BASED TREATMENT

This alternative is the same as C-3 except the outer ring is spray irrigated after secondary treatment and nutrient removal in the regional treatment plants. Urban runoff wastes will be treated at the point of discharge as discussed previously in this chapter.

Sludge from large municipal plants would be incinerated with the ash used for landfill. Digested sludge from the smaller treatment plants would be spread on the land for possible land reclamation or for use as a soil conditioner.

The system proposed for the "inner ring" is the basic system of alternative W-1 and the discussion of W-1 is applicable to the "inner ring" of this alternative. The system presented in C-1 is the same as the system proposed for the "outer ring" in this plan. The discussion of C-1 is appropriate for the "outer ring" of C-4.

This alternative could be the first interim stage in developing a total land alternative such as L-1. Present facilities in the outer ring could be used continuously. Construction of the transmission facilities and spray irrigation system for just the outer ring would have less of an economic burden on the area, and possibly could be started in the time frame of 1975-1985 if the institutional arrangements could be provided. Further, removal of the waste loads from the upper reaches of the Rocky and Cuyahoga River has a favorable impact on the river quality for several miles. As the existing facilities become obsolete, the system could be converted to C-3 with aerated lagoon treatment.

10. PRELIMINARY ESTIMATES OF COST

This section presents preliminary estimates of cost for construction of the various eight plans. Operation and maintenance costs are not provided; however, these costs would have substantial effect on the total annual cost.

TABLE IV-17

PRELIMINARY ESTIMATES OF COST

W-1

		Estimated Cost, Millions of Dollars	
A - Municipal and Industrial Wastes			
1.	Sewage Treatment Plants (Primary, Secondary and Tertiary)	$ 661	
	Sub-Total		$ 661
B - Storm Runoff			
1.	Collection Systems	$1,250	
2.	Stabilization Basins	679	
	Sub-Total		$1,929
	Total Construction Cost		$2,590
	Overhead Costs* (35%±)		910
	TOTAL		$3,500

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

TABLE IV-17

PRELIMINARY ESTIMATES OF COST

W-2

		Estimated Cost Millions of Dollars	
A - Municipal and Industrial Wastes			
1.	Sewage Treatment Plants (Primary, Secondary and Tertiary)	$ 661	
	Sub-Total		$ 661
B - Storm Runoff			
1.	Collection Systems	$1,250	
2.	Storage and Transmission Facilities	281	
3.	Sewage Treatment Plants Expansion	595	
	Sub-Total		$2,126
	Total Construction Cost		$2,787
	Overhead Costs* (35%±)		973
	TOTAL		$3,760

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

TABLE IV-17

PRELIMINARY ESTIMATES OF COST

L-1

	Estimated Cost Millions of Dollars	
A - Municipal and Industrial Wastes		
1. Transmission Facilities	$ 710	
2. Aerated Lagoon Treatment	48	
3. Storage Facilities	539	
4. Spray Irrigation (including transmission from storage to irrigation site)	1,414	
5. Return to watershed	510	
Sub-Total		$3,221
B - Storm Runoff		
1. Collection and Transmission Facilities	$1,431	
2. Storage Facilities	161	
3. Percolation Facilities	38	
4. Return to Watershed	17	
Sub-Total		$1,647
Total Construction Cost		$4,868
Overhead Costs* (35%±)		1,702
TOTAL		$6,570

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

TABLE IV-17

PRELIMINARY ESTIMATES OF COST

L-2

		Estimated Cost Millions of Dollars
A - Municipal and Industrial Wastes		
1. Transmission Facilities	$ 710	
2. Aerated Lagoon Treatment	48	
3. Storage Facilities	287	
4. Percolation Facilities (including transmission from storage to percolation site)	165	
5. Nutrient Removal Facilities	200	
6. Return to watershed	299	
Sub-Total		$1,709
B - Storm Runoff		
1. Collection and Transmission	$1,431	
2. Storage Facilities	161	
3. Percolation Facilities	38	
4. Return to Watershed	17	
Sub-Total		$1,647
Total Construction Cost		$3,356
Overhead Costs* (35%±)		1,174
TOTAL		$4,530

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

TABLE IV-17

PRELIMINARY ESTIMATES OF COST

C-1

		Estimated Cost Millions of Dollars
A - Municipal and Industrial Wastes		
1. Transmission Facilities	$ 710	
2. Storage Facilities	539	
3. Spray Irrigation (including transmission from storage to irrigation site)	1,414	
4. Return to watershed	510	
5. Sewage Treatment Plants	461	
Sub-Total		$3,634
B - Storm Runoff		
1. Collection Systems	$1,250	
2. Stabilization Basins	679	
Sub-Total		$1,929
Total Construction Cost		$5,563
Overhead Costs* (35%±)		1,947
TOTAL		$7,510

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

TABLE IV-17

PRELIMINARY ESTIMATES OF COSTS

C-2

		Estimated Costs, Million of Dollars	
A - Municipal and Industrial Wastes			
1.	Transmission Facilities	$ 710	
2.	Storage Facilities	287	
3.	Percolation Facilities	165	
4.	Return to Watershed	299	
5.	Sewage Treatment Plants	461	
	Sub-Total		$1,922
B - Storm Runoff			
1.	Collection Systems	$1,250	
2.	Stabilization Basins	679	
	Sub-Total		$1,929
	Total Construction Cost		$3,851
	Overhead Costs* (35%±)		1,349
	TOTAL		$5,200

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

TABLE IV-17

PRELIMINARY ESTIMATES OF COST

C-3

		Estimated Costs, Millions of Dollars
A - Municipal and Industrial Wastes		
(a) Outer Ring:		
1. Transmission Facilities	$ 177	
2. Aerated Lagoon Treatment	14	
3. Storage Facilities	125	
4. Spray Irrigation (including transmission from storage to irrigation site)	343	
5. Return to Watershed	145	
(b) Inner Ring:		
6. Sewage Treatment Plants (including tertiary treatment)	492	
Sub-Total		$1,296
B - Storm Runoff		
1. Collection Systems	$1,250	
2. Stabilization Basins	679	
Sub-Total		$1,929
Total Construction Cost		$3,225
Overhead Costs* (35%±)		1,125
TOTAL		$4,350

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

TABLE IV-17

PRELIMINARY ESTIMATES OF COST

C-4

		Estimated Costs Millions of Dollars
A - Municipal and Industrial Wastes		
(a) Outer Ring:		
1. Transmission Facilities	$ 177	
2. Storage Facilities	125	
3. Spray Irrigation including transmission from storage to irrigation	343	
4. Return to Watershed	145	
5. Sewage Treatment Plants	112	
(b) Inner Ring:		
6. Sewage treatment plants (including tertiary treatment)	492	
Sub-Total		$1,394
B - Storm Runoff		
1. Collection Systems	$1,250	
2. Stabilization Basins	679	
Sub-Total		$1,929
Total Construction Cost		$3,323
Overhead Costs* (35%±)		1,167
TOTAL		$4,490

*Overhead costs include contingencies, engineering, supervision of construction and administrative costs.

11. PROGRAM FOR LOWER CUYAHOGA INDUSTRIAL VALLEY

The pollution problems experienced in the lower reach of the Cuyahoga River are so concentrated and so severe that special consideration should be given this area. A preliminary program for improvement of the lower Cuyahoga is outlined herein, and may be regarded as a program common to all of the foregoing alternatives.

The "lower Cuyahoga" as used herein is defined as the entire reach from the confluence of Big Creek, (near the Harvard-Denison Bridge) to the mouth, a length of 7.2 miles. The dredged navigation channel constitutes the downstream 5.7 miles of this reach.

Problems

The principal pollution problems identified in this reach are:

(1) High oxygen demand (BOD, COD and nitrogenous) - The total present oxygen demand has been estimated in recent studies at about 450,000 to 500,000 lbs. per day.

(2) Low reaeration rate, low velocity and low D.O. - During summer low flow periods, D.O. is virtually zero. Time of travel through the lower reach at critical low flow is about 6 days.

(3) Floating oil, scum and debris.

(4) Industrial waste discharges - Including ammonia, phenols, cyanides, pickling liquors, acids, heavy metals, plating wastes, oil, unoxidized iron compounds, solids, paint residues and solvents. Industrial firms in the valley have reduced discharges of these materials within the past two years, but substantial quantities of these materials are still being discharged.

(5) Temperature - Discharges of cooling waters contribute to high temperatures which exceed 95°F during critical low flow periods.

(6) Sediment and other suspended solids - The Corps of Engineers removes approximately 1,220,000 cubic yards of dredgings from the navigation channel and harbor annually.

(7) Dissolved solids - Dissolved solids in the navigation channel average about 750 mg/l, and have been measured as high as 1,700 mg/l.

(8) Municipal sewage loads from combined sewer overflows and tributary streams - In Cleveland, about 275 combined sewer overflows discharge to the Cuyahoga or to its tributaries in this reach. These tributaries are Big Creek, Mill Creek, Morgan Run, Walworth Run, Burke Brook, and Kingsbury Run.

These discharges contain raw sewage and surface runoff containing BOD, COD, suspended solids, oils and greases and other constituents, and heavy bacterial contamination.

Remedial Measures

The basic program suggested for solving the problems outlined consists of several remedial measures:

(1) Reduce pollution loadings entering the reach from upstream by implementing the selected alternative. Principal benefit to the lower Cuyahoga would be to reduce loadings of suspended solids and oxygen demanding wastes from Cleveland Southerly and Akron treatment plants.

(2) Oils, greases, tar, asphalt, paint residues and solvents should be collected from throughout the study area by tank truck and reclaimed or disposed of at a central plant. The old refinery waste treatment plant site at Kingsbury Run has been given to the City of Cleveland, is suitable for this purpose, and is centrally located.

It is proposed that waste oil from filling stations, machine shops, and other sources would be picked up by scavenger truck periodically, and

that the cost of this disposal service be carried by a service charge. Large industrial waste producers could deliver wastes to the plant in their own trucks. This effort must be accompanied by adequate enforcement of existing ordinances prohibiting discharge of these materials to the sewer systems.

Higher quality waste oils could be reclaimed and sold to reduce cost of disposal. Residues would be incinerated in high efficiency retort burners fitted with complete air pollution control devices.

(3) Heavy metals, plating wastes, pickling liquor, acids, and similar industrial wastes from steel mills, fabricators and other metal-working industries should be collected and treated in a separate industrial waste facility. These wastes are inorganic toxic materials not suitable for biological treatment, and are all commonly treated by similar processes such as neutralization, chemical precipitation and chemical-physical separation. Treated effluent waters would be discharged to the municipal sewer system for additional treatment, and residual chemical sludges would be disposed of either by reclamation of usable precipitates or by permanent burial or storage preventing release to the environment.

This centralized metal waste treatment could be incorporated with the treatment facility at the Kingsbury Run site, or could be located elsewhere. Again, the cost of collection and treatment of these wastes would be borne by the users.

(4) Strong industrial wastes suitable for biological oxidation treatment, such as phenols, ammonia and certain rubber industry wastes can be handled in small quantities at municipal treatment plants. However, the quantities of these wastes generated in steel mill coke production

and in rubber processing within the study area is beyond the capability of the municipal treatment plants to handle successfully. Such strong oxygen demanding wastes should be pre-treated at the point of origin prior to discharge to the municipal system.

(5) Temperature - In order to reduce temperatures in the lower Cuyahoga to acceptable levels, two general plans should be considered:

(a) Installation of cooling towers at the steel mills and other large consumers of cooling water, to reduce heat discharges.

(b) Augmentation of flow through the lower Cuyahoga channel to reduce temperature, either by pumping Lake Erie raw water to the head of navigation, or by re-use of treated effluent imported from one of the disposal sites of the strategy plan adopted. In order to have the effect desired, such imported water would have to amount to a net increase in total river flow.

(6) Dissolved Solids - Concentration of dissolved solids exceeds present water quality standards part of the time, and this problem is projected to become worse. The principal dissolved solids constitutents are chlorides and sulfates, which are difficult and costly to remove, and are not normally removed either by water or land treatment processes. In order to reduce dissolved solids, concentrated sources of dissolved solids within the river basin should be identified and these concentrated sources should provide high degree dissolved solids removal by one or more of the following processes:

(a) Ion exchange

(b) Reverse osmosis

(c) Electroylsis

(d) Distillation

Consideration should be given to financing this type of treatment on a regional basis.

(7) Combined Sewer Overflows and Urban Runoff - To control pollution from these sources, interception and treatment of some portion of the runoff is required. This will involve:

(a) Provision of up-system storage and diversion structures at selected points to divert greater quantities of wastes to the municipal sewer system for treatment, within the capabilities of the treatment plants. This would eliminate dry weather discharges and those from low-intensity storms, and would reduce the runoff rate from the larger storms to subsequent treatment facilities.

(b) In order to intercept remaining flow now discharged to the Cuyahoga River, construct a large interceptor (probably in tunnel) capable of handling all flows up to 1-year storm. This interception tunnel would pick up flows from all tributaries downstream of Big Creek and convey them to a storm water treatment facility located at one of the following points:

1. Along south bank of the old Cuyahoga River channel at the west end.
2. In the old Cuyahoga River channel itself, after improvement for this purpose.
3. At the Cleveland Westerly Treatment Plant site, if adequate space could be made available.

This runoff-wastewater would be combined with the Cleveland west side runoff (collected from the proposed West Diversion Conduit) for treatment. Discharge of the treated runoff would be to the old Cuyahoga River channel, or via tunnel into Lake Erie.

(8) Debris and Oil Collection - Institute a continuous system for collection of residual oil, debris and other floating materials. This system would consist of a pneumatic barrier across Cuyahoga River at Kingsbury Run to collect floating oil and to concentrate this oil so that it may be skimmed. Skimming equipment is already available for this purpose. Continuous and permanent debris collection, including removal of trees, snags, etc., should be instituted throughout the Cuyahoga basin, and especially in the navigation channel. At present debris collection is sporadic and not adequate. Costs should be allocated throughout the region. There is currently available a plan, with necessary equipment, for containment and removal of heavy accidental oil spills.

(9) Sediment - The Corps of Engineers estimates that approximately 550,000 cubic yards of sediment could be intercepted and removed by a suitable settlement basin in the Cuyahoga River, located between the Southerly plant and the head of navigation. Removal of the sediment under this plan would improve the quality of the lower Cuyahoga River water and reduce the annual dredgings volume by about 45%. Removal of sediment from this collection basin would be mechanized, and the removed wastes would be disposed of on permanent fill sites on land. Care would have to be exercised to prevent pollution by discharge of overflow water.

(10) Dissolved Oxygen - Remedial measures mentioned above and in the Strategy Plans would greatly reduce the present dissolved oxygen deficit in the lower Cuyahoga River. However, some residual wastes exerting oxygen demand would remain, and some nitrogenous oxygen demand would also be exerted. It is estimated that even after all of the recommended programs are in effect, a residual oxygen demand of approximately 20,000 lbs./day may remain.

With the very low velocity and poor reaeration characteristics of the river in the navigation channel reach, even a small oxygen demand will produce severe oxygen deficit in this reach. In order to provide satisfactory dissolved oxygen levels, it is proposed to install artificial river reaeration at multiple sites (approximately six), which would withdraw water from the navigation channel, reaerate it by injection of either air or pure oxygen, and return the aerated water back into the river.

Preliminary engineering plans have previously been prepared for this project and a pilot study to determine the necessary gas transfer rates and similar design parameters has been prepared.

It is evident that the problems discussed above are of regional origin. The remedial programs, therefore should be financed and operated by some regional agency, and the costs should be allocated to all contributors throughout the basin. Institutional arrangements for such an agency are an urgent requirement.

12. PROCESSES CONSIDERED BUT ELIMINATED

Certain variations of plans were considered but rejected after preliminary evaluation. For information, these are listed briefly as follows:

a) Disposal of raw sewage or industrial wastes by direct irrigation. Rejected because of public health aspects, soil clogging by oil solids, odors and other problems.

b) Ridge and furrow irrigation. Rejected because terrain in Ohio is not suitable. To achieve the flat grades required would require excessive earth grating.

c) High rate spreading or percolation systems using natural soils in situ. The heavy clay - silt soils encountered in the area are not suitable for the high percolation rates required.

d) Release of all treated wastewaters to underground aquifers through percolation, without underdrainage. Both soil characteristics and effects of the very large volumes of water to be handled (about 1.1 billion gallons daily during the summer irrigation season) preclude such a system. Underground aquifers are not available in this region to accept flows even approaching this magnitude, and deep soil strata would not be capable of transporting flows at this rate.

e) Use of simple oxidation ponds for basic treatment. Although such ponds (up to 30" in depth) can successfully carry out biological oxidation, the vast land areas required to treat the flows from a metropolitan area make this impracticable.

f) Treatment of all runoff water. The very large quantities of water involved make this economically unfeasible. A 1-year storm frequency has been used to define the quantity of runoff to be treated.

g) Deep well disposal of municipal wastewater, industrial wastewater, and runoff wastes was rejected on the basis of the enormous storage volumes required and the inability to assure the protection of ground water resources.

h) Spray irrigation with runoff wastes was deemed infeasible due to the large land and the low nutrient concentrations of the runoff.

i) Segregated industrial wastes were not considered for spray irrigation due to the noxious characteristics of these wastes. High rate spreading basins for these industrial wastewaters was also ruled out due to the poor removals of contaminants that would be expected from such a system.

j) Composting was rejected as a method of municipal sludge handling on the basis of the poor performance record of American composting operations.

k) Numerous variations and combinations of the alternatives are possible, and some were considered. In order to achieve a manageable number of alternatives, selections were made as the basis of judgment as to the most feasible possibilities.

D. SUMMARY, AND NEEDS FOR FURTHER STUDY OR ADDITIONAL DATA

1. SUMMARY

The data given in the preceding parts of the Feasibility Study was used in Section IV in development of eight alternative strategy plans. Of these, two plans are presented for water-based strategies, two for land-based strategies, and four for combinations of land and water strategies.

Preliminary estimates of capital cost and land requirements are presented. Capital costs are for information only, and should not be used for comparative evaluation between plans, since the plans would vary widely in operating costs, and selection should only be made on a total annual cost basis.

In the evaluation of impacts, it should be recognized that the various plans are not identical in treatment effectiveness. Overall process efficiencies are given in Table IV-2.. For example, C-3 does not involve as high degree of reliability of nutrient removal as W-1 or W-2, since underdrainage is not treated for this purpose.

Estimates presented herein for treatment efficiency of land disposal plans should be regarded as preliminary. Very little factual data is available on large scale applications, and reliability of data in the literature cannot be regarded as good.

2. NEEDS FOR FURTHER STUDY AND ADDITIONAL DATA

During conduct of the feasibility study, it is recognized that serious and broad data gaps exist, and that extensive work is required to obtain reliable information for the survey scope studies. Some of these data gaps are:

a) Detailed hydrographs of the streams are needed, with hydrologic model of each basin.

b) System models are needed for the watersheds to relate discharge of pollutants to physical parameters such as stream flow, and storm events.

c) Many outfalls and discharge points remain unidentified as to flow, degree and type of pollutant constituents, and variability of these factors.

d) Much detailed information is needed on characteristics, distribution and classification of soils in Northeast Ohio. Suitability of the soils for irrigation and application rates, the underlying geology, ground water conditions, and related matters also need thorough study.

e) Extensive study and pilot scale operation is needed on land disposal systems. Subjects such as adsorption and/or leaching of dissolved salts, metals, nutrients and biological organisms, underdrainage, spray application, and other subjects, need definitive study for the systems considered. Data now available is fragmentary and in some respects contradictory.

   Particularly important is the matter of long-range equilibrium conditions, breakthrough curves, and their effect on ground water resources and the land itself.

f) Salinity and salt build-up require special consideration, along with mineral tolerance of various crops.

g) Benefits or detrimental effects of sludge application to land requires detailed demonstration.

h) Possible use or disposal of grasses or other cover crops on irrigated lands needs careful evaluation. Nearby markets may not be available.

i) Characterization and impact of runoff wastes needs additional work.

j) Industrial waste quantities and characteristics should be studied in detail, including opportunities for reclamation, recycle and disposal.

k) Effects of erosion and possibilities for erosion control and sediment capture require detailed evaluation.

l) Methods of obtaining public acceptance and cooperation for land disposal systems should be carefully explored in advance of selection of any given alternative.

m) Institutional restraints on regional systems (whether water or land) must be carefully studied and resolved. These include:

  (1) Methods of funding regional projects.

  (2) Institutional agencies with the power and resources to carry out regional systems do not exist, and must be conceived and created probably by legislative action.

  (3) Methods of bringing about financial equity among political subdivisions in any regional system must be devised. These may involve some sort of subsidies.

  (4) Methods of pollution control enforcement should improve.

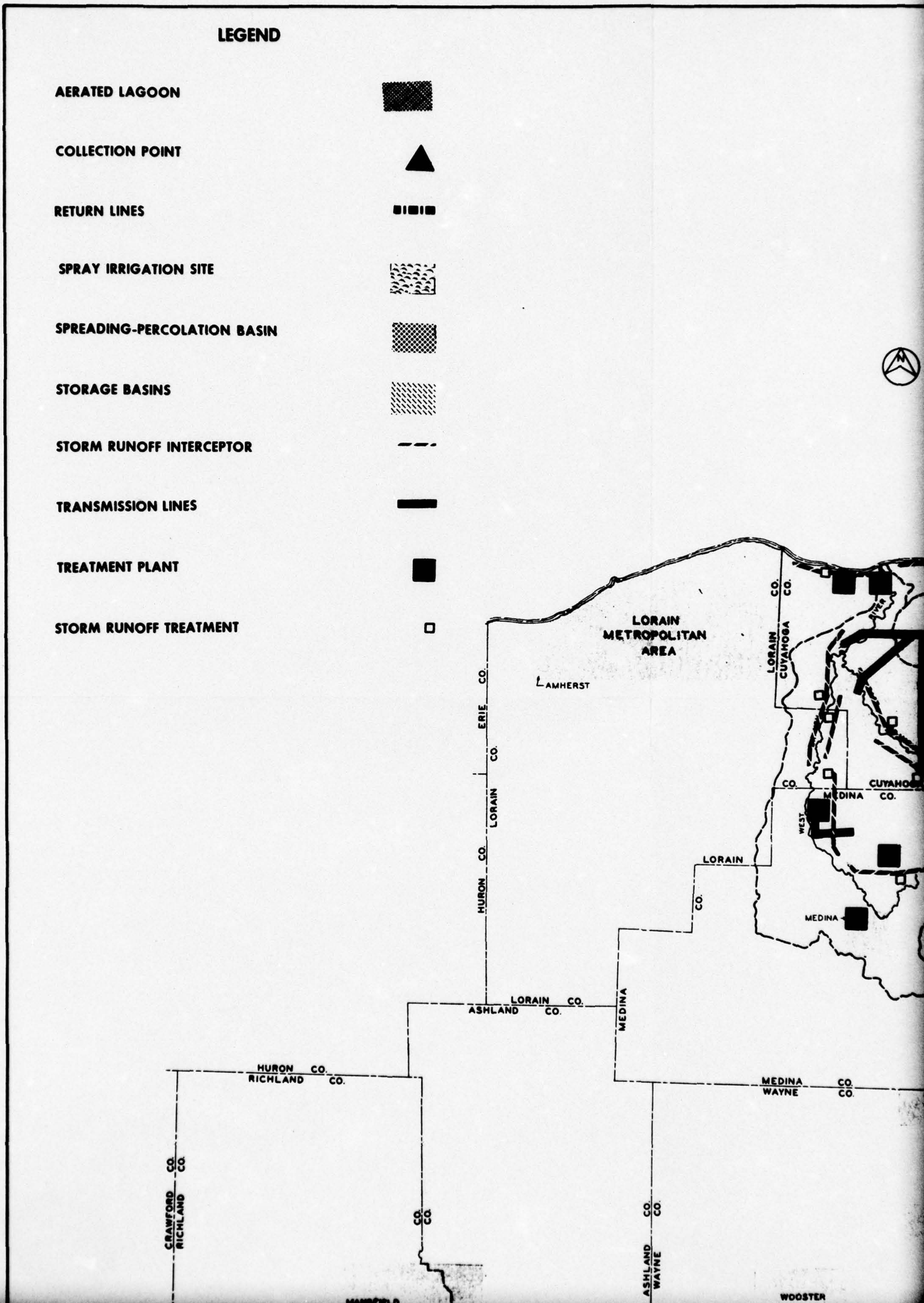
  (5) Restraints on inter-basin water transfers, which may include international treaties, should be explored. The land alternatives suggested herein envision return of most of the treated effluent to the Three Rivers basin and Lake Erie, but a small fraction of the waters could be lost to ground water transfer to the Ohio basin.

n) Public health impact of each strategy should be evaluated.

o) Pathogenic bacteria and virus removal should be studied in depth.

p) Wastewater sampling should go beyond the commonly measured parameters to include trace elements, pesticides, and other toxic materials.

q) Great need for future work is in the area of sludge handling. Improved methods of concentrating and disposing of sludges and residues, with emphasis on recovery and recycling should be developed.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RETURN LINES
SPRAY IRRIGATION SITE
SPREADING-PERCOLATION BASIN
STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
ERIE CO.
LORAIN CO.
HURON CO.
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CUYAHOGA CO.
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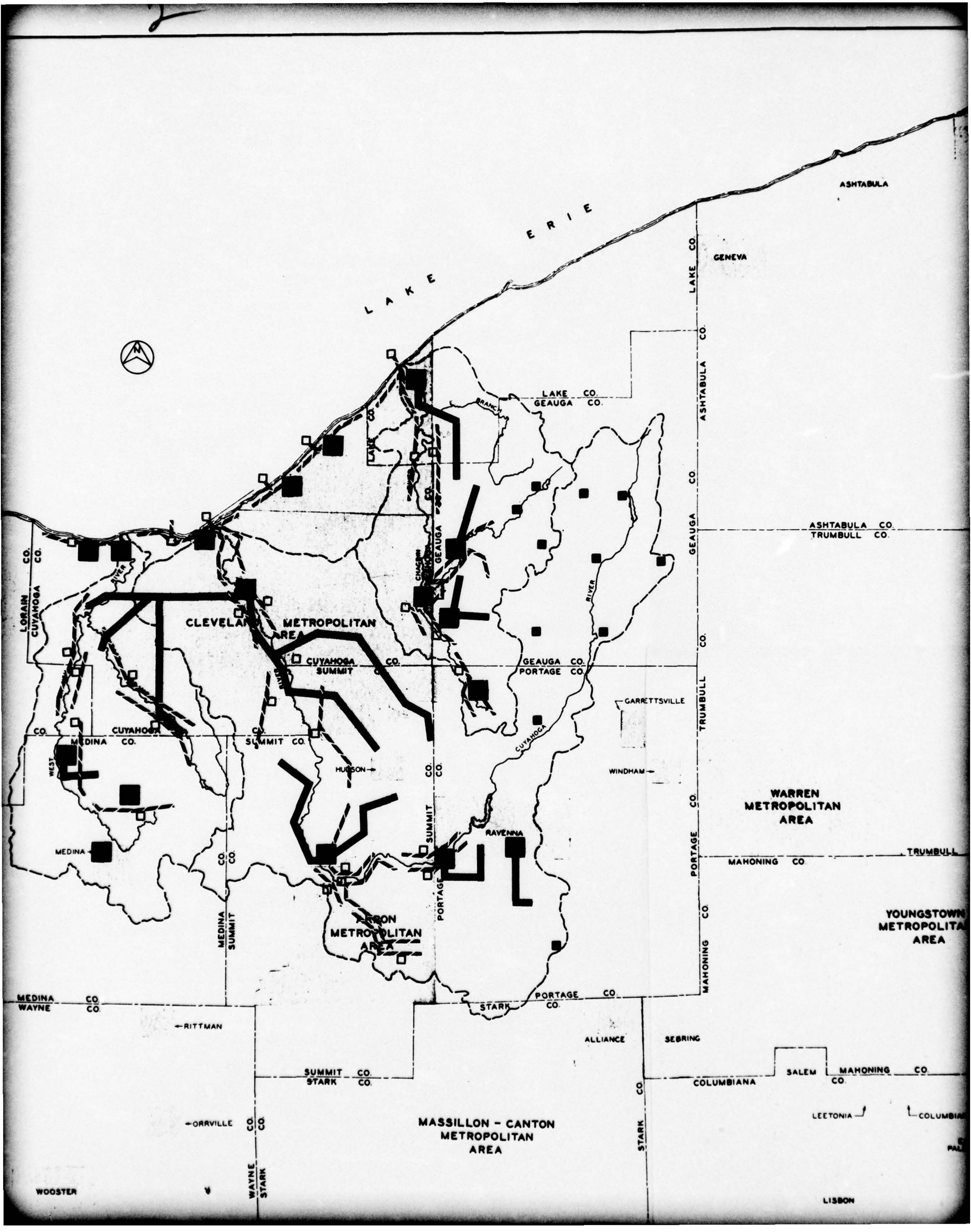
MANSFIELD
WOOSTER



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PORTAGE CO.
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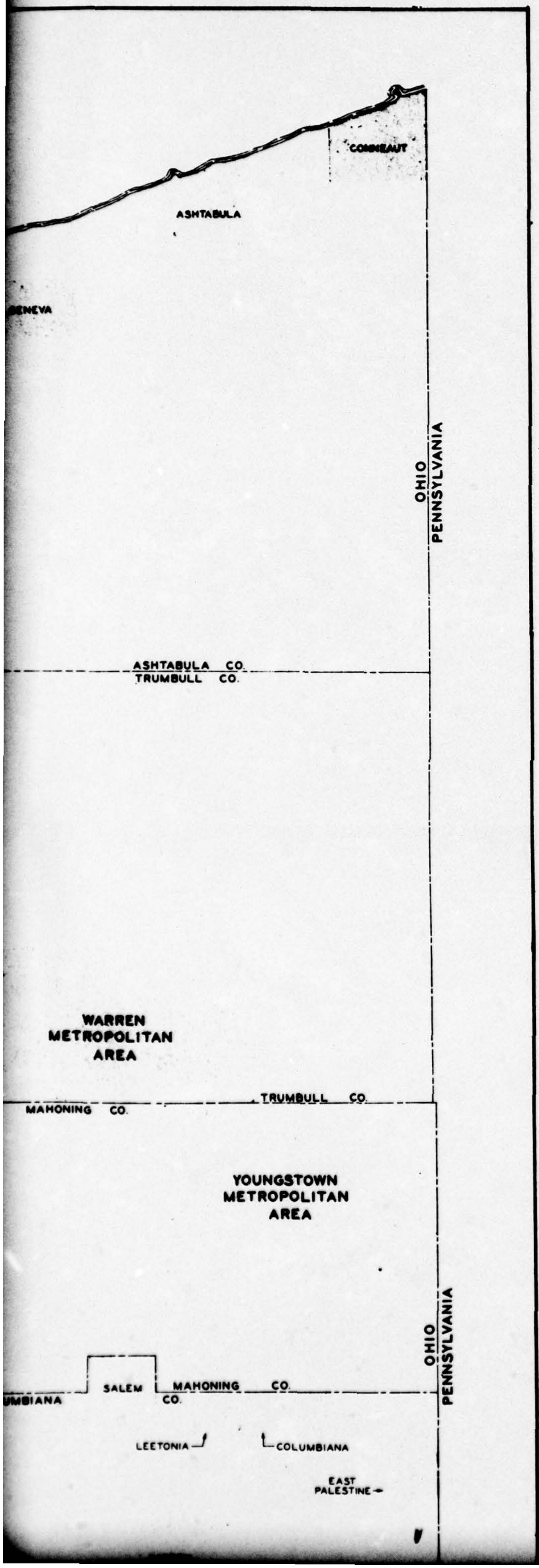

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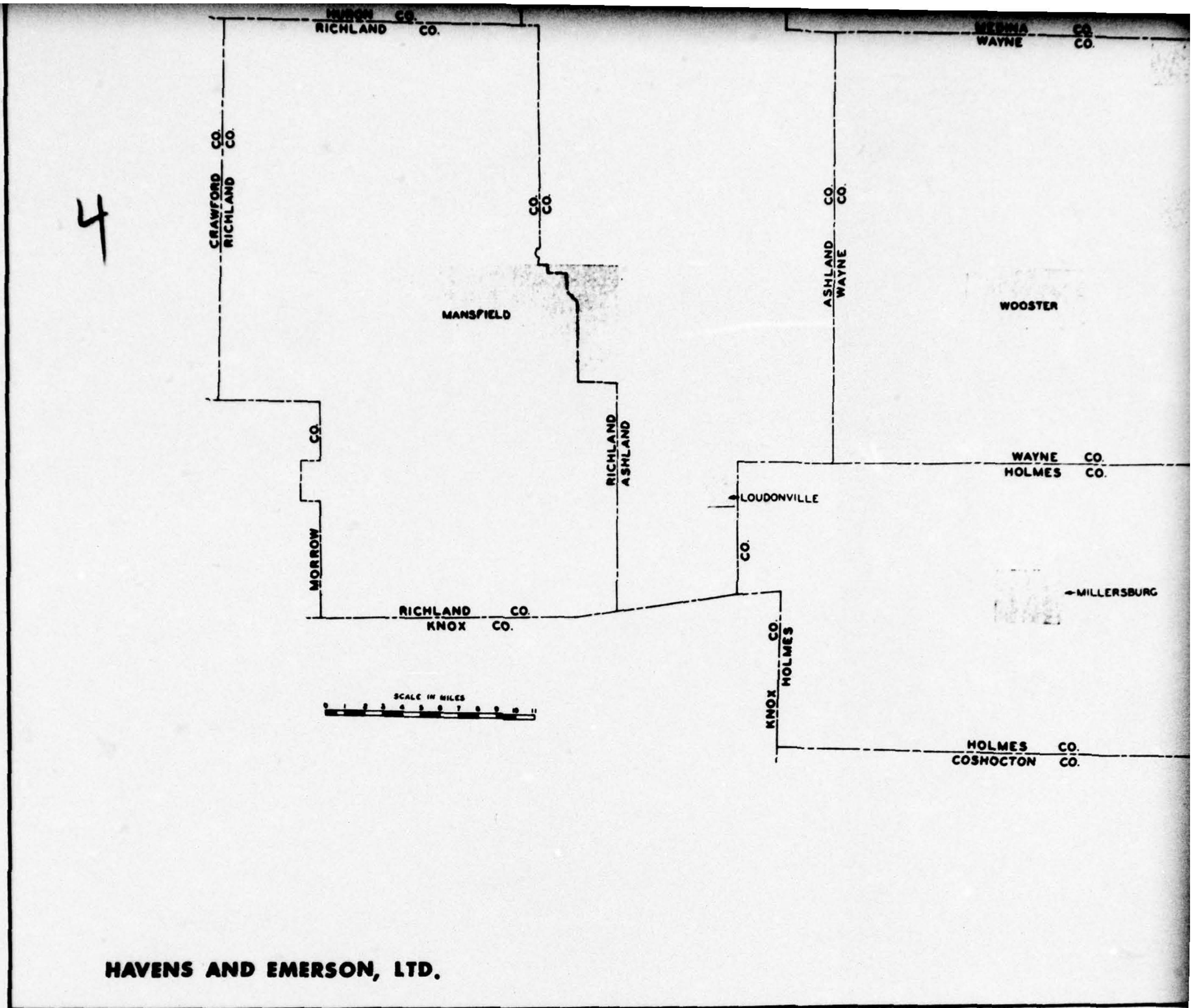
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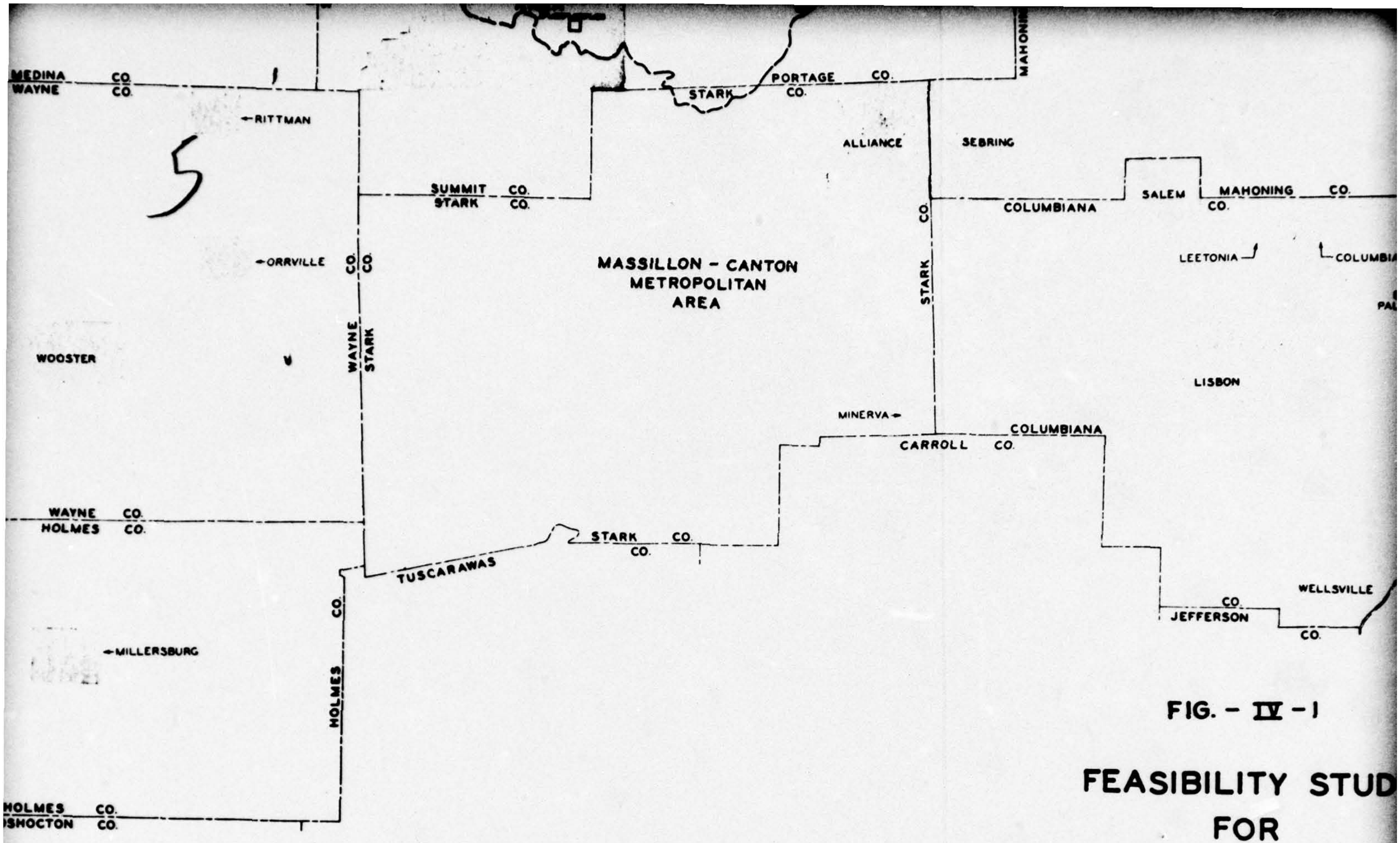

FIG. - IV - 1

FEASIBILITY STUD

FOR

WASTEWATER MANAGEMENT

W-1

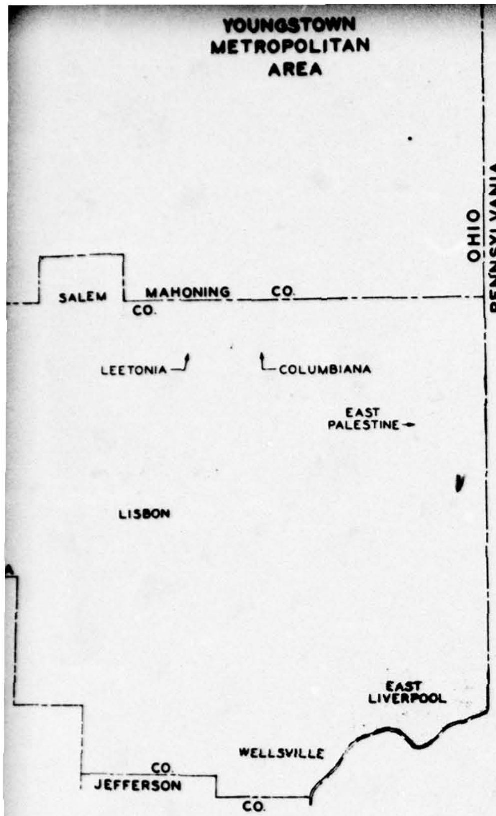

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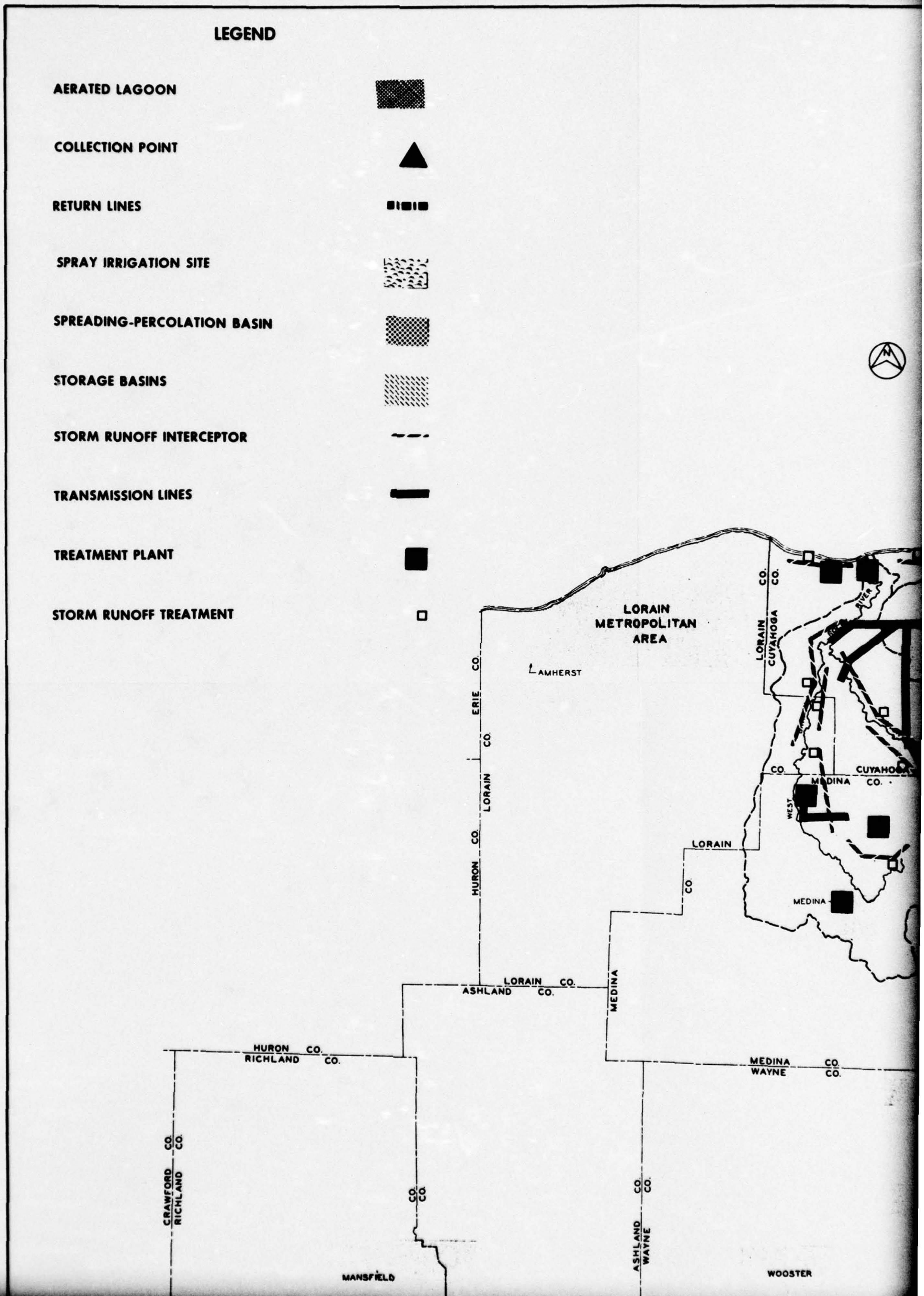
FIG. - IV - 1

FEASIBILITY STUDY
FOR
TER MANAGEMENT PROGRAM

W-1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TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
LORAIN CO.
CUYAHOGA CO.
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MEDINA CO.
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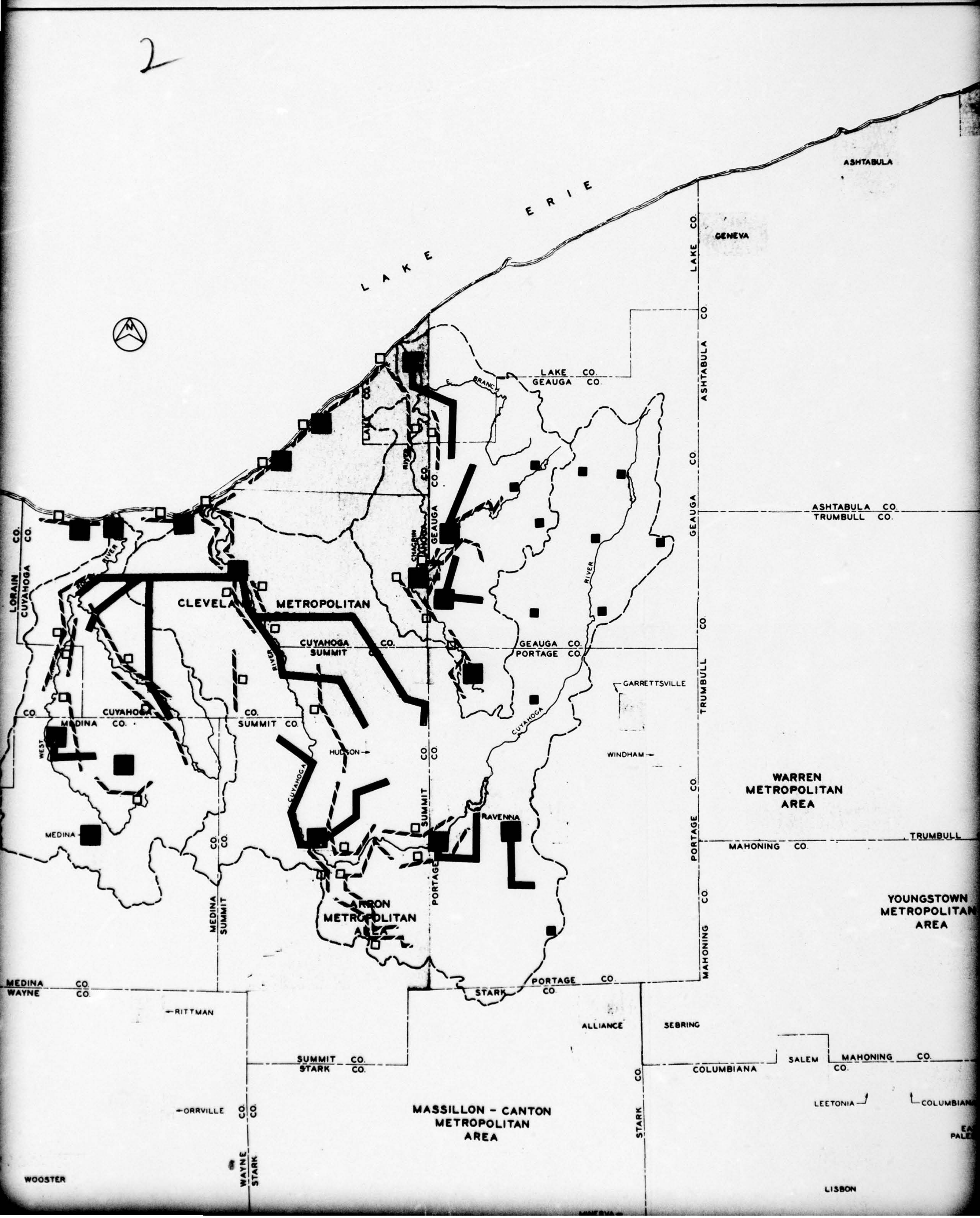
MANSFIELD
WOOSTER

2



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SALEM
MAHONING CO.
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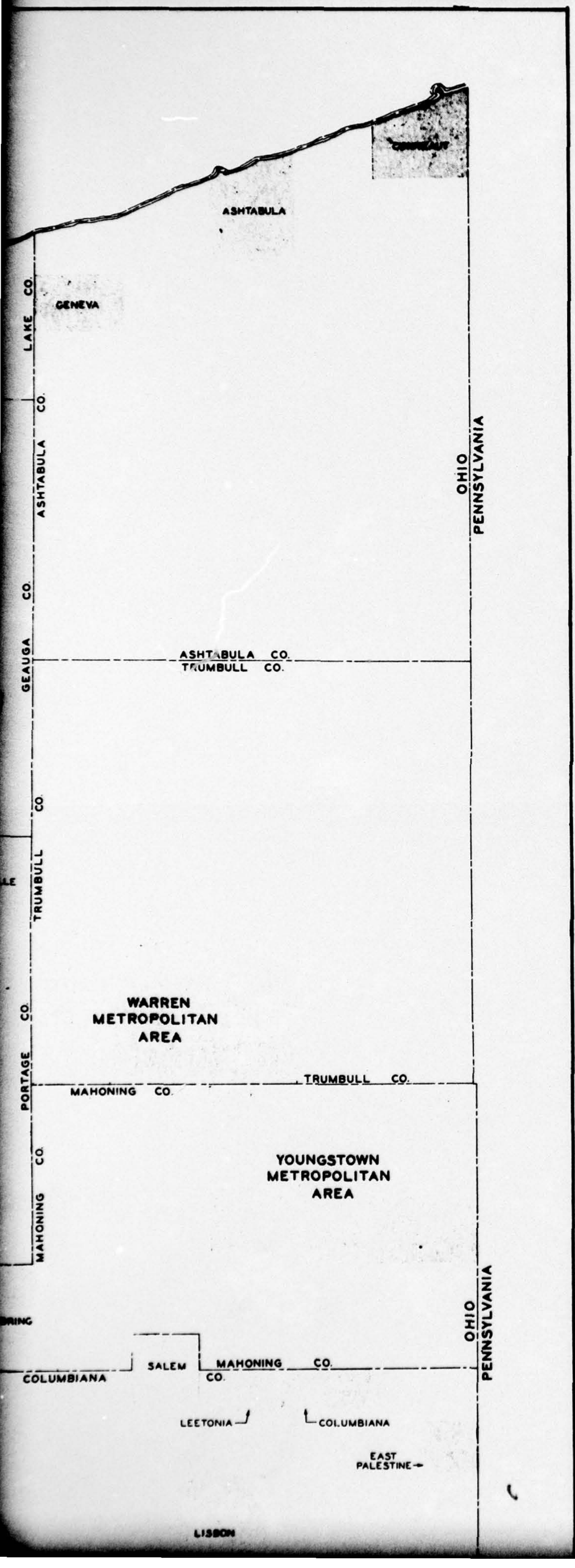
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PORTAGE CO.
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MAHONING CO.
YOUNGSTOWN METROPOLITAN AREA
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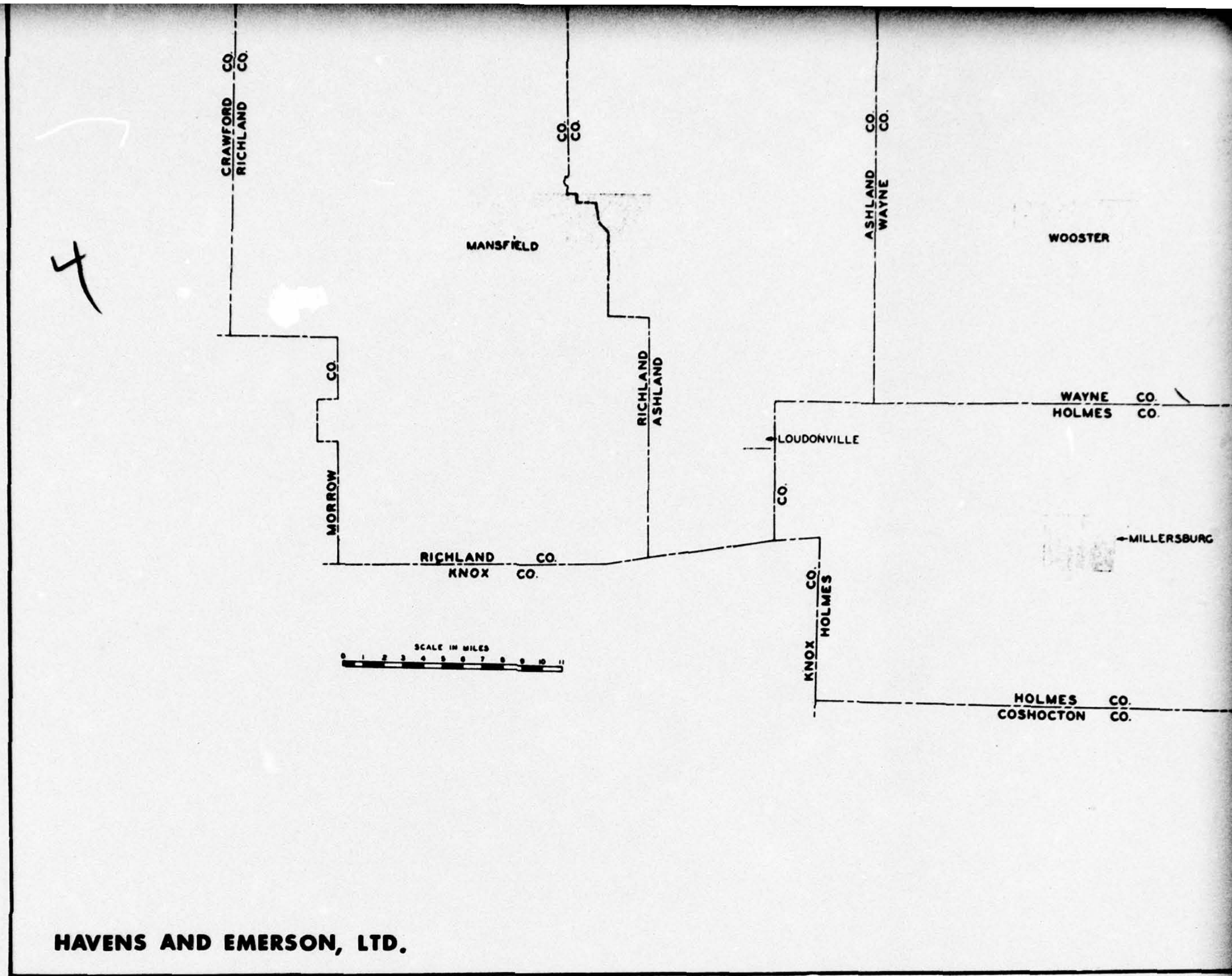
EAST PALESTINE
LISBON



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HOLMES CO.
LOUDONVILLE
CO.
MILLERSBURG
RICHLAND CO.
KNOX CO.
KNOX CO.
HOLMES
SCALE IN MILES
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HOLMES CO.
COSHOCTON CO.
HAVENS AND EMERSON, LTD.
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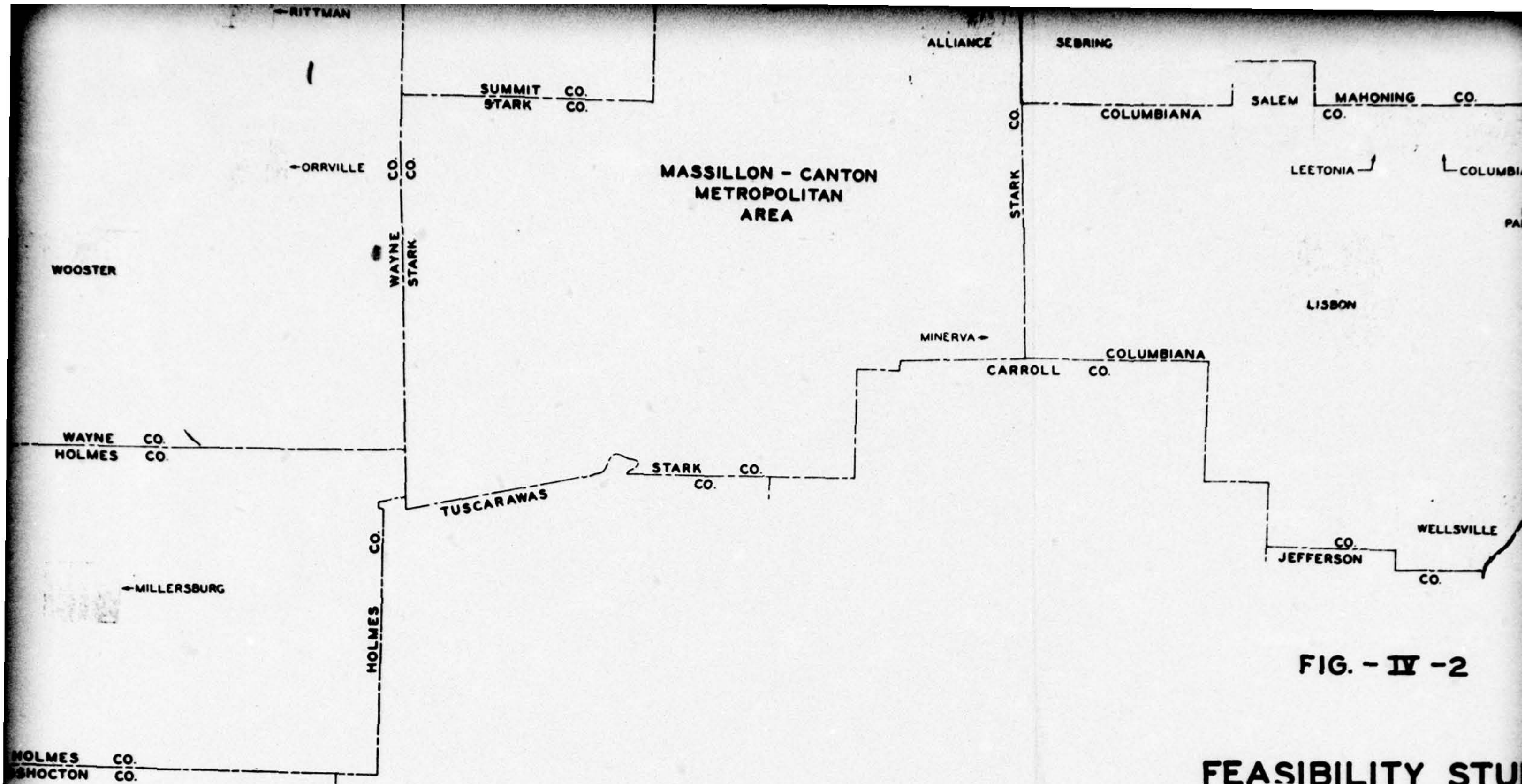


5

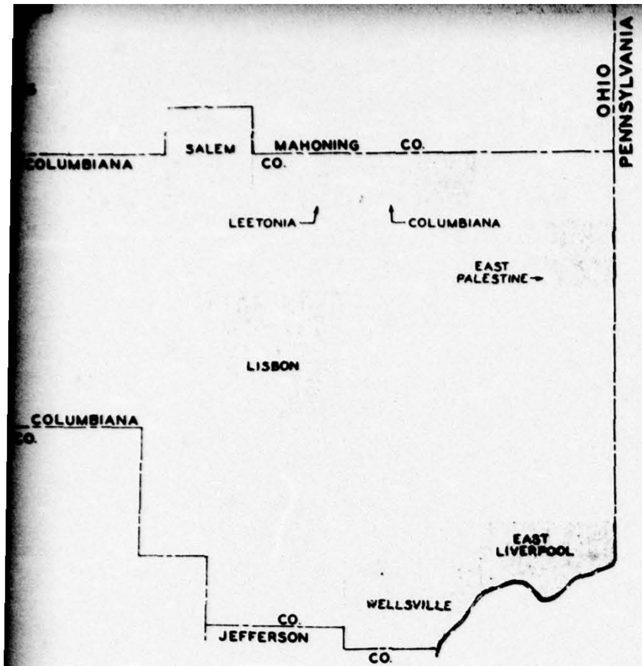
FIG. - IV -2

FEASIBILITY STU

FOR

WASTEWATER MANAGEMEN

W-2

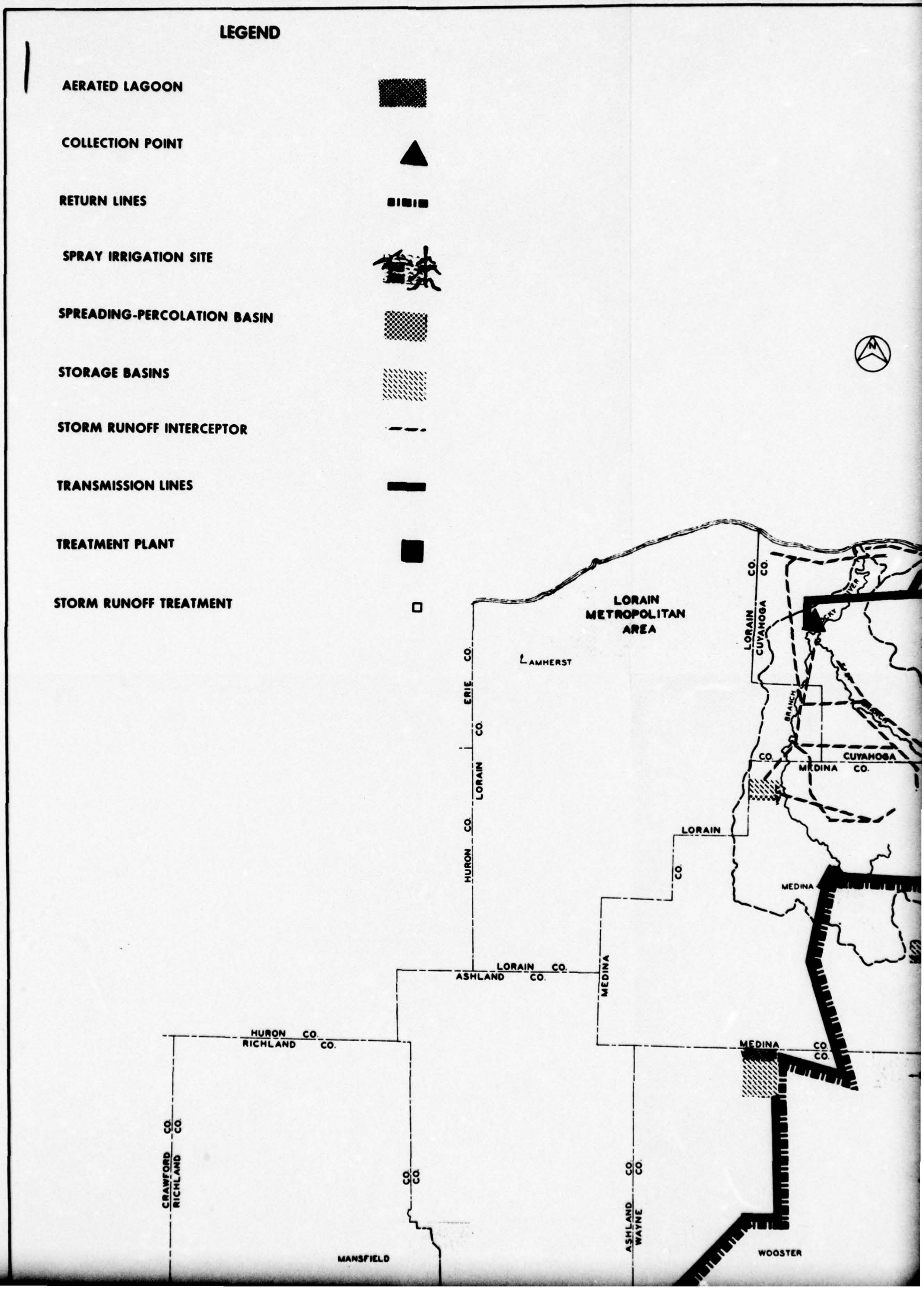


6

FIG. - IV -2

FEASIBILITY STUDY
FOR
STEWATER MANAGEMENT PROGRAM

W-2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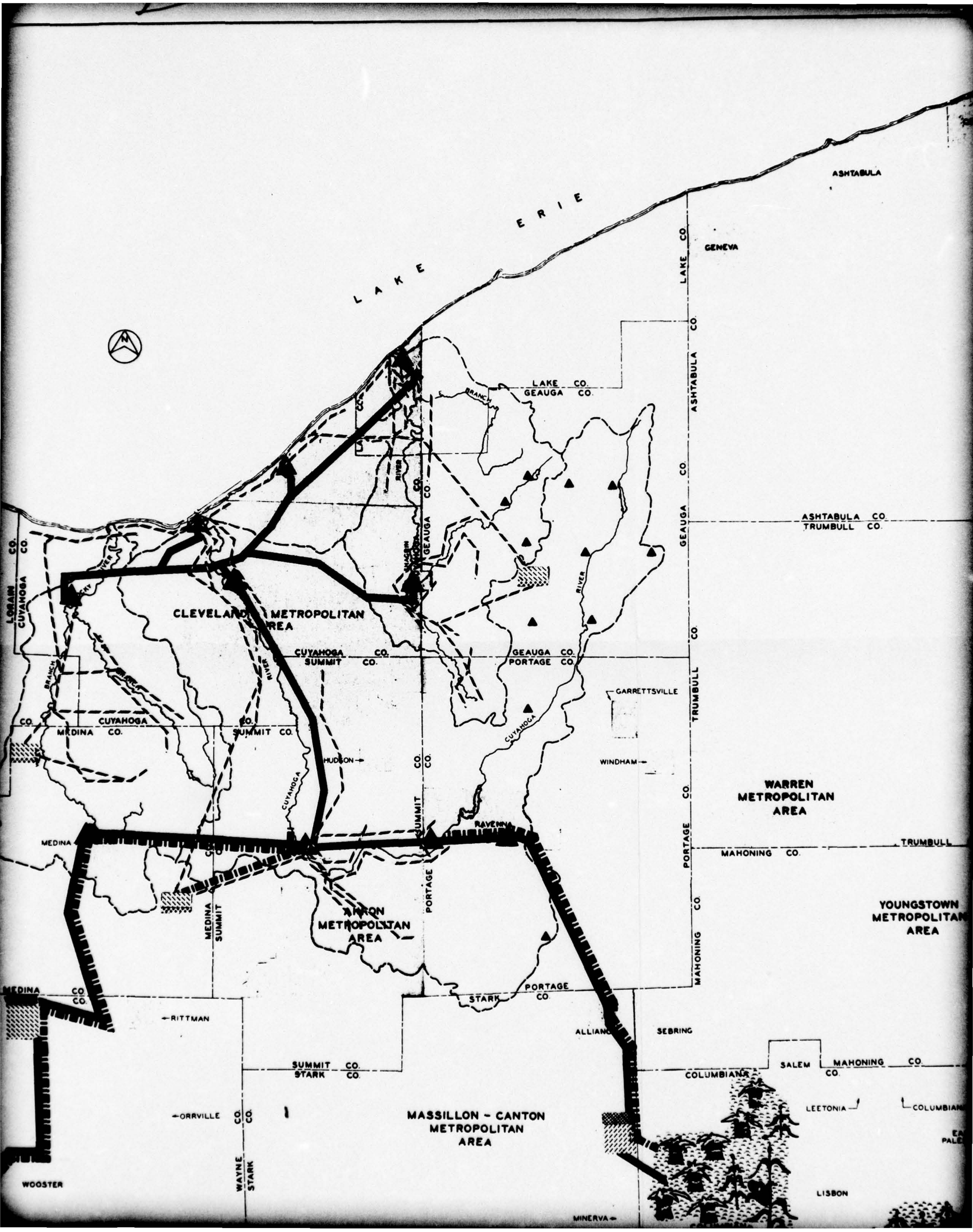
COLLECTION POINT
RETURN LINES
SPRAY IRRIGATION SITE
SPREADING-PERCOLATION BASIN
STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
ERIE CO.
LORAIN CO.
HURON CO.
LORAIN CO.
CUYAHOGA CO.
MEDINA CO.
CUYAHOGA
LORAIN
CO.
MEDINA
LORAIN CO.
ASHLAND CO.
MEDINA
HURON CO.
RICHLAND CO.
MEDINA
CO.
CO.
CRAWFORD CO.
RICHLAND CO.
ASHLAND CO.
WAYNE CO.
MANSFIELD
WOOSTER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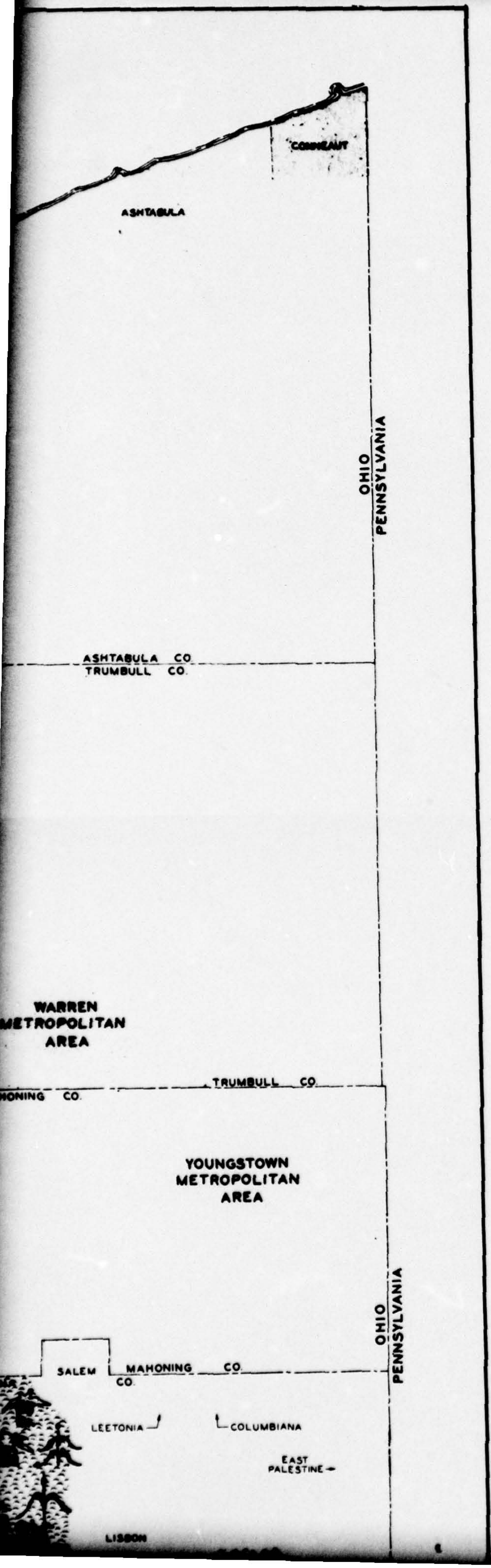
GENEVA
LAKE CO.
ASHTABULA CO.
LAKE CO.
GEAUGA CO.
ASHTABULA CO.
TRUMBULL CO.
GEAUGA CO.
LORAIN CO.
CUYAHOGA CO.
CLEVELAND METROPOLITAN AREA
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
GARRETTSVILLE
CUYAHOGA CO.
MEDINA CO.
SUMMIT CO.
HUDSON
WINDHAM
WARREN METROPOLITAN AREA
TRUMBULL
MAHONING CO.
MEDINA
RAVENNA
AKRON METROPOLITAN AREA
YOUNGSTOWN METROPOLITAN AREA
MEDINA SUMMIT
PORTAGE
MAHONING CO.
MEDINA CO.
RITTMAN
STARK
PORTAGE CO.
ALLIANCE
SEBRING
SUMMIT CO.
STARK CO.
COLUMBIANA
SALEM
MAHONING CO.
LEETONIA
COLUMBIANA
ORRVILLE
MASSILLON - CANTON METROPOLITAN AREA
WAYNE STARK
WOOSTER
LISBON
MINERVA
CUYAHOGA
RIVER
BRANCH

3



CONNEAUT
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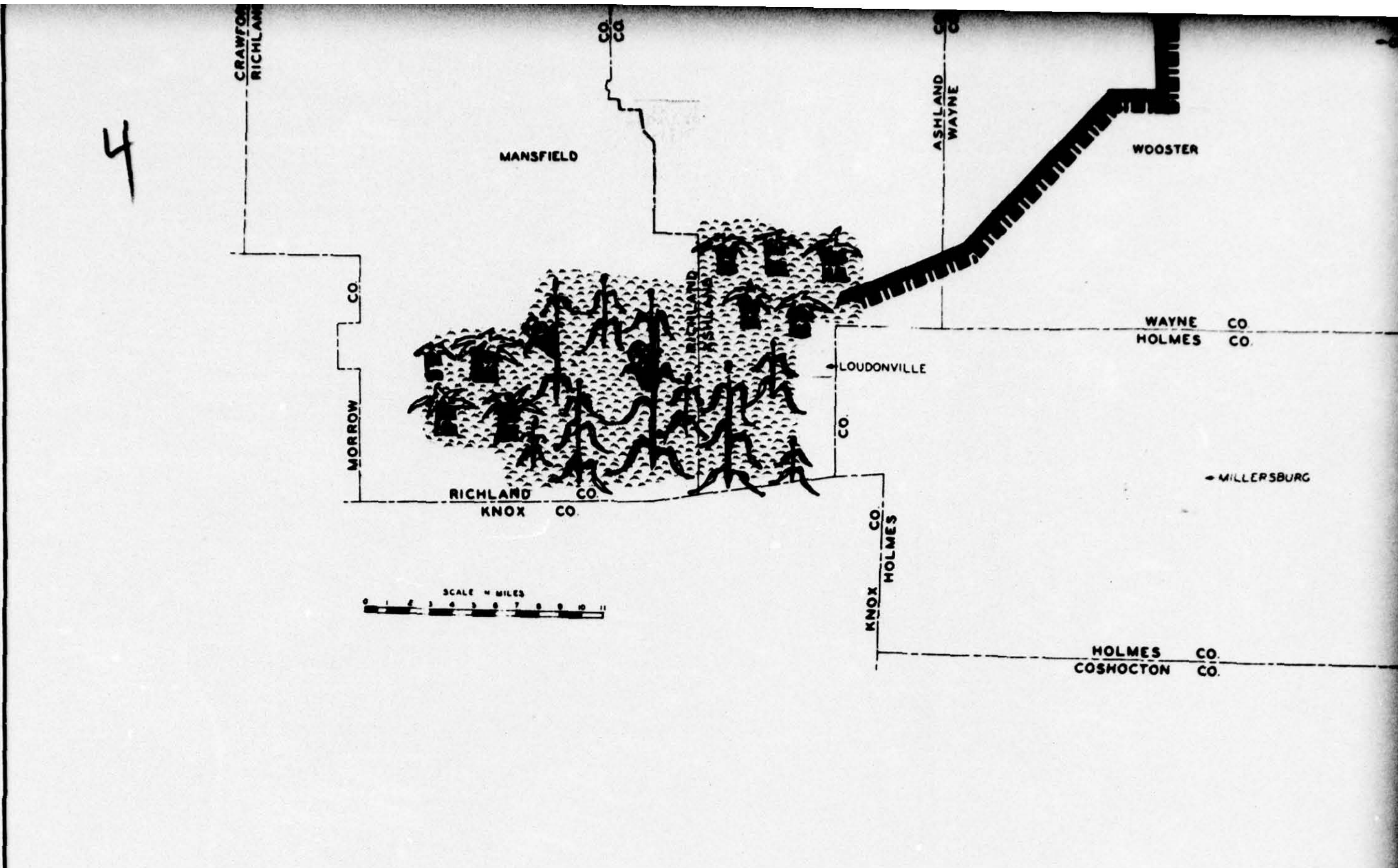
OHIO
PENNSYLVANIA
ASHTABULA CO.
TRUMBULL CO.
WARREN
METROPOLITAN
AREA
TRUMBULL CO.
HONING CO.
YOUNGSTOWN
METROPOLITAN
AREA
OHIO
PENNSYLVANIA
SALEM
MAHONING CO.
CO.
LEETONIA
COLUMBIANA
EAST
PALESTINE
LISBON



HAVENS AND EMERSON, LTD.

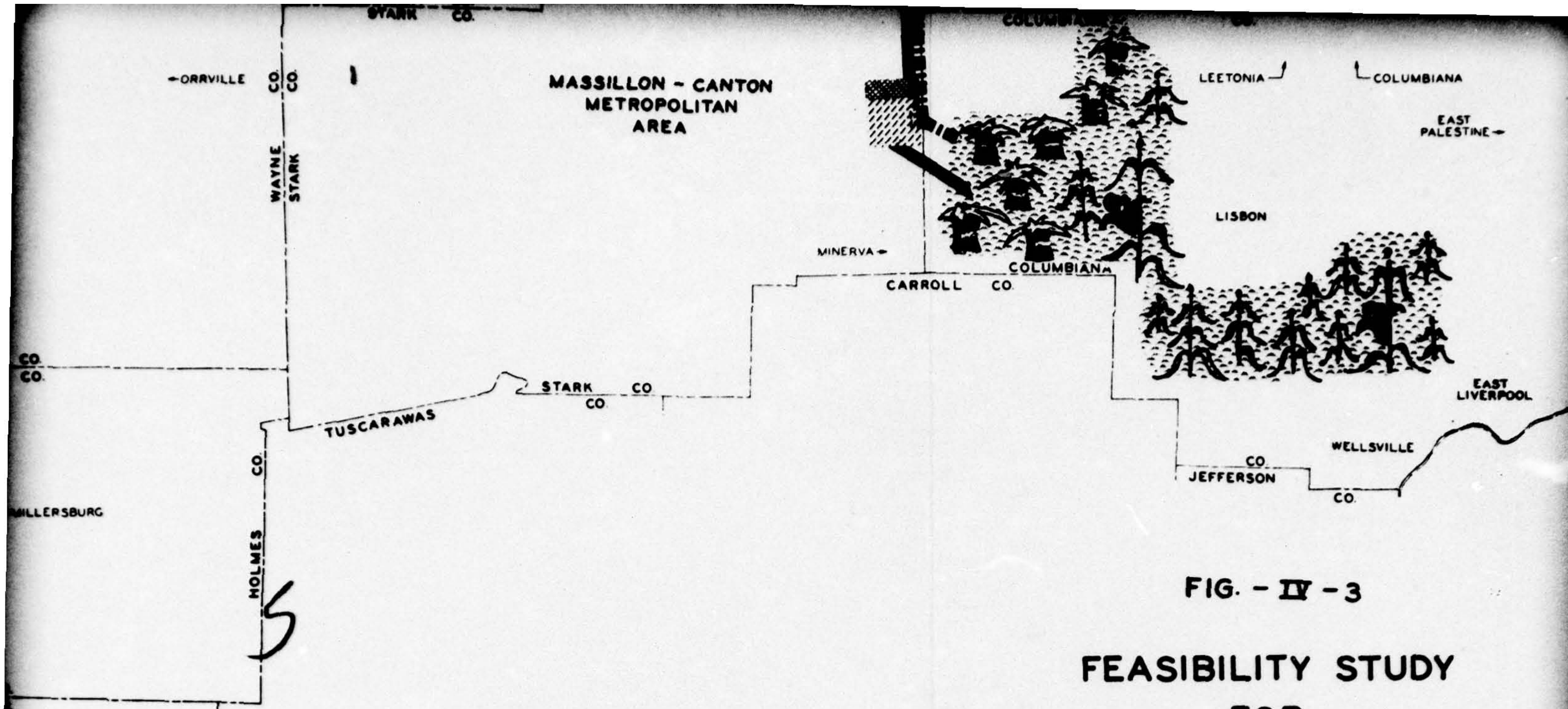


FIG. - IV - 3

FEASIBILITY STUDY

FOR

WASTEWATER MANAGEMENT PROG

L-1

6

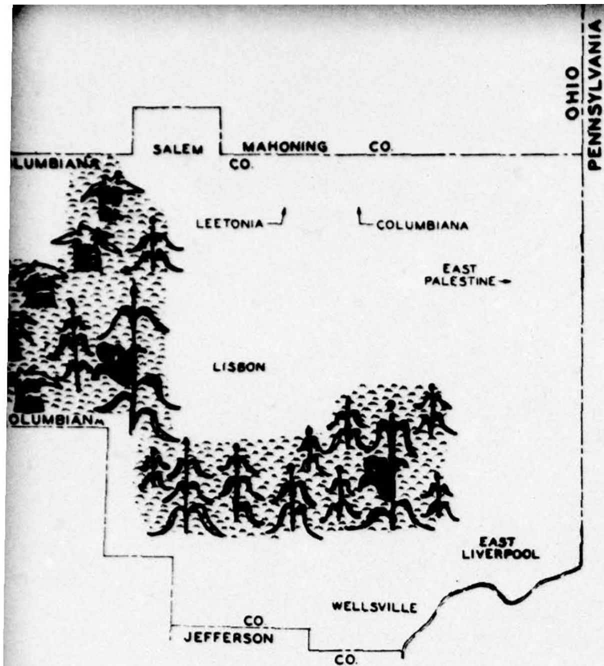
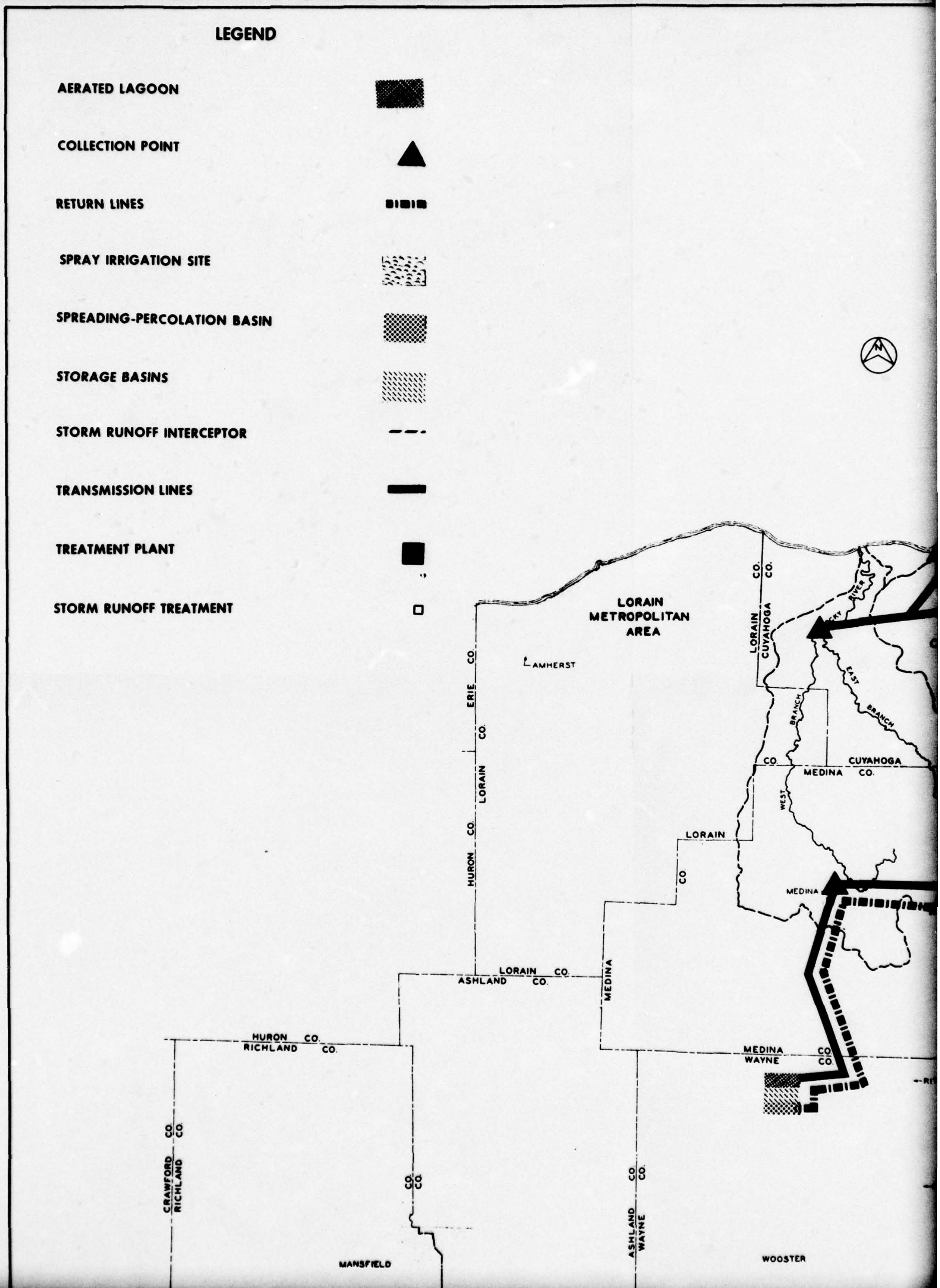


FIG. - IV - 3

FEASIBILITY STUDY
FOR
EWATER MANAGEMENT PROGRAM

L-1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RETURN LINES
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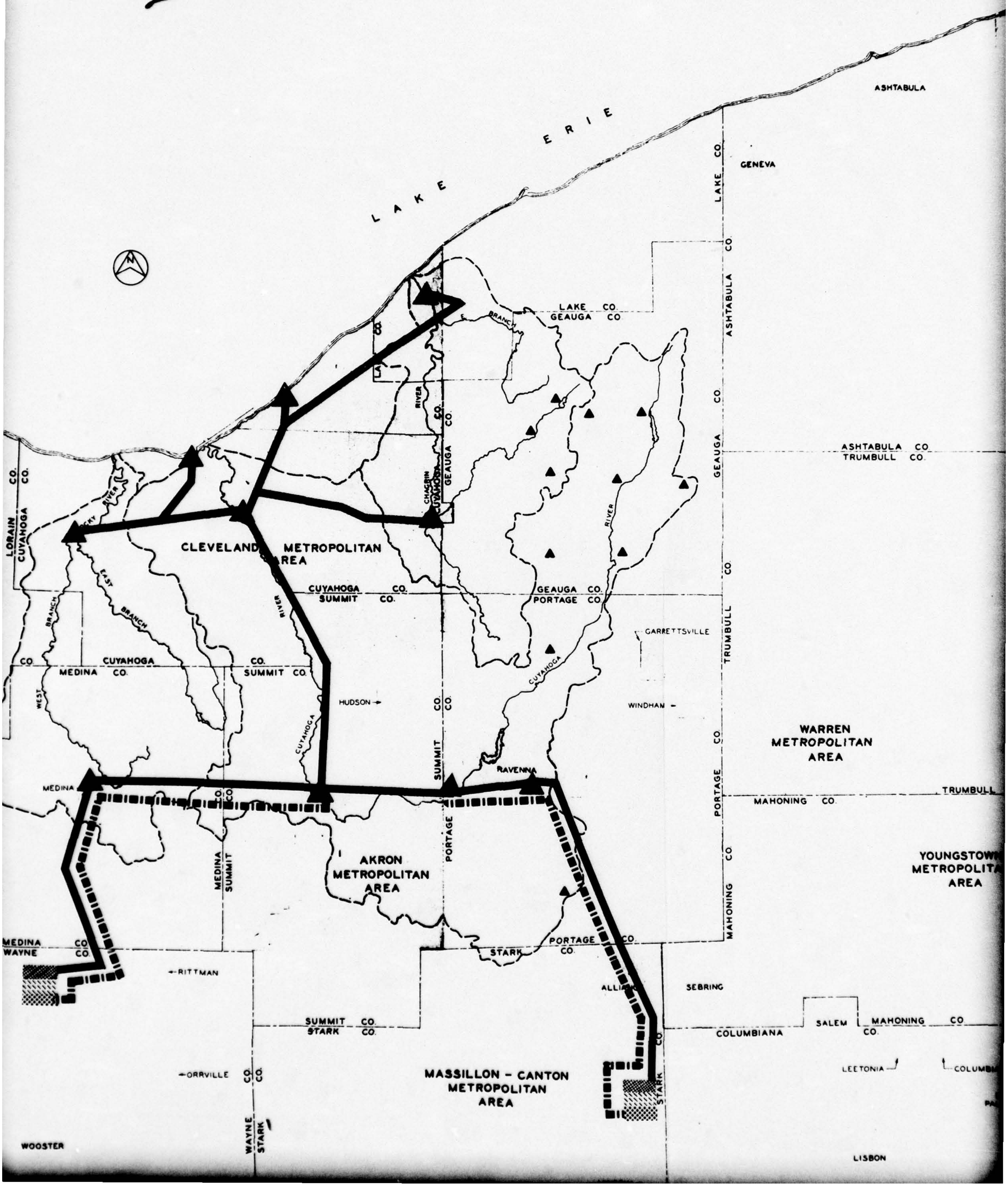
SPREADING-PERCOLATION BASIN
STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
LORAIN CO.
CUYAHOGA CO.
ERIE CO.
LORAIN CO.
HURON CO.
EAST BRANCH
WEST BRANCH
CUYAHOGA CO.
MEDINA CO.
LORAIN
CO.
MEDINA
LORAIN CO.
ASHLAND CO.
MEDINA
HURON CO.
RICHLAND CO.
MEDINA CO.
WAYNE CO.
CRAWFORD CO.
RICHLAND CO.
CO.
CO.
ASHLAND CO.
WAYNE CO.
MANSFIELD
WOOSTER

2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GENEVA
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GEAUGA CO.
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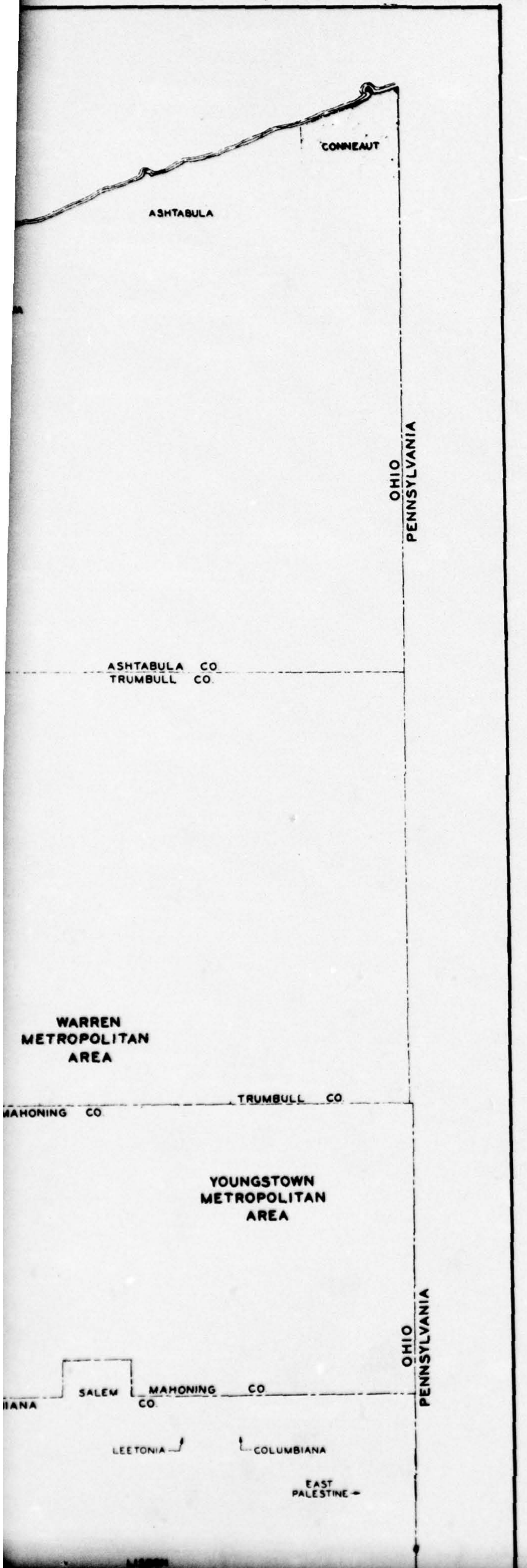
TRUMBULL CO.
GEAUGA CO.
LORAIN CO.
CUYAHOGA CO.
CLEVELAND METROPOLITAN AREA
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
GARRETTSVILLE
TRUMBULL CO.
CUYAHOGA CO.
MEDINA CO.
SUMMIT CO.
HUDSON
WINDHAM
WARREN METROPOLITAN AREA
MEDINA
RAVENNA
TRUMBULL
MAHONING CO.
AKRON METROPOLITAN AREA
YOUNGSTOWN METROPOLITAN AREA
MEDINA CO.
WAYNE CO.
RITTMAN
PORTAGE CO.
STARK CO.
SEBRING
SUMMIT CO.
STARK CO.
COLUMBIANA
SALEM
MAHONING CO.
ORRVILLE
MASSILLON - CANTON METROPOLITAN AREA
LEETONIA
WOOSTER
LISBON

3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OHIO
PENNSYLVANIA
ASHTABULA CO
TRUMBULL CO
WARREN
METROPOLITAN
AREA
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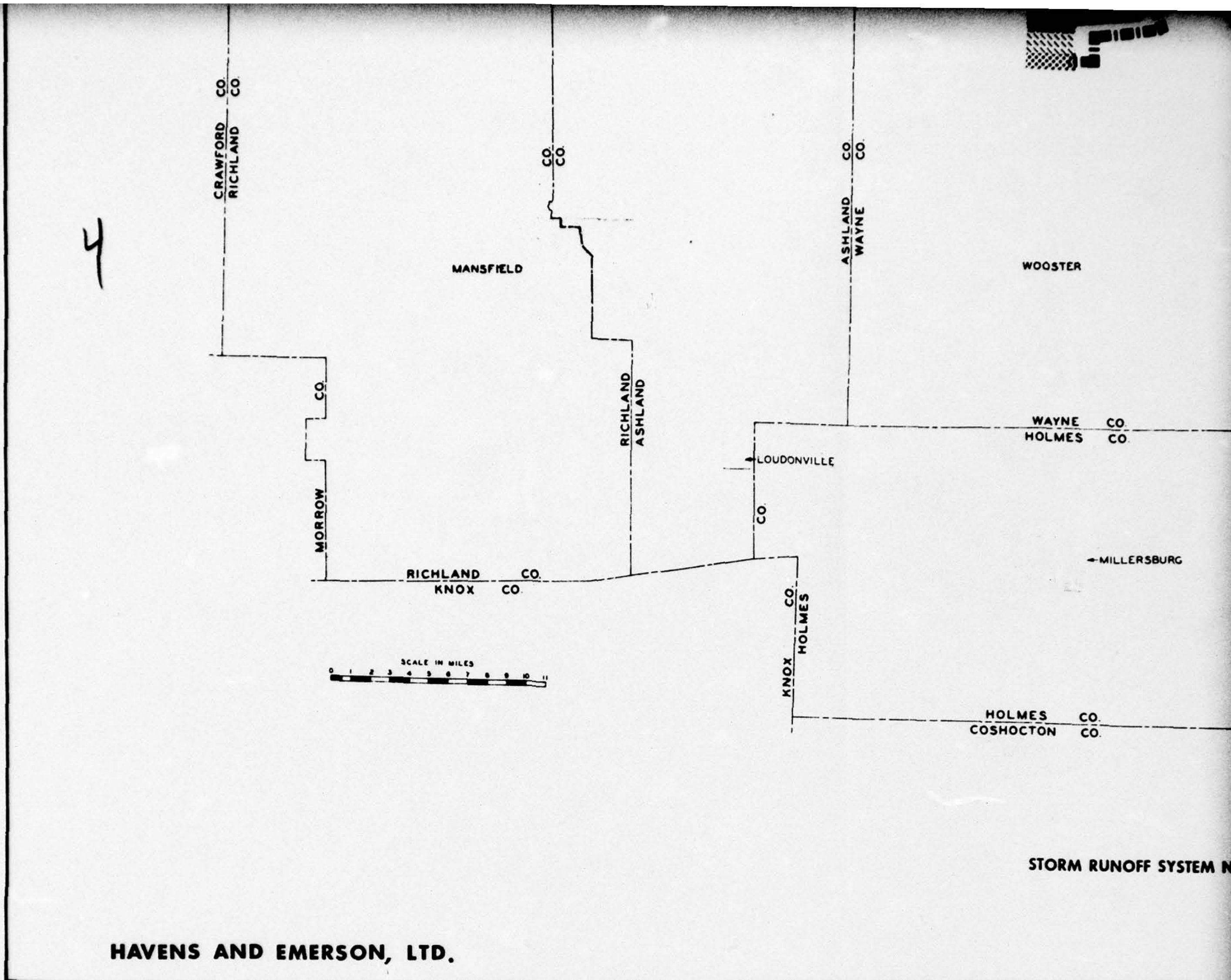
MAHONING CO
YOUNGSTOWN
METROPOLITAN
AREA
OHIO
PENNSYLVANIA
SALEM
MAHONING CO
CO
LEETONIA
COLUMBIANA
EAST
PALESTINE


CRAWFORD CO.
RICHLAND CO.
CO.
CO.
ASHLAND CO.
WAYNE CO.
4
MANSFIELD
WOOSTER
MORROW CO.
RICHLAND
ASHLAND
WAYNE CO.
HOLMES CO.
LOUDONVILLE
CO
MILLERSBURG
RICHLAND CO.
KNOX CO.
KNOX CO.
HOLMES
SCALE IN MILES
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HOLMES CO.
COSHOCTON CO.
STORM RUNOFF SYSTEM NO
HAVENS AND EMERSON, LTD.

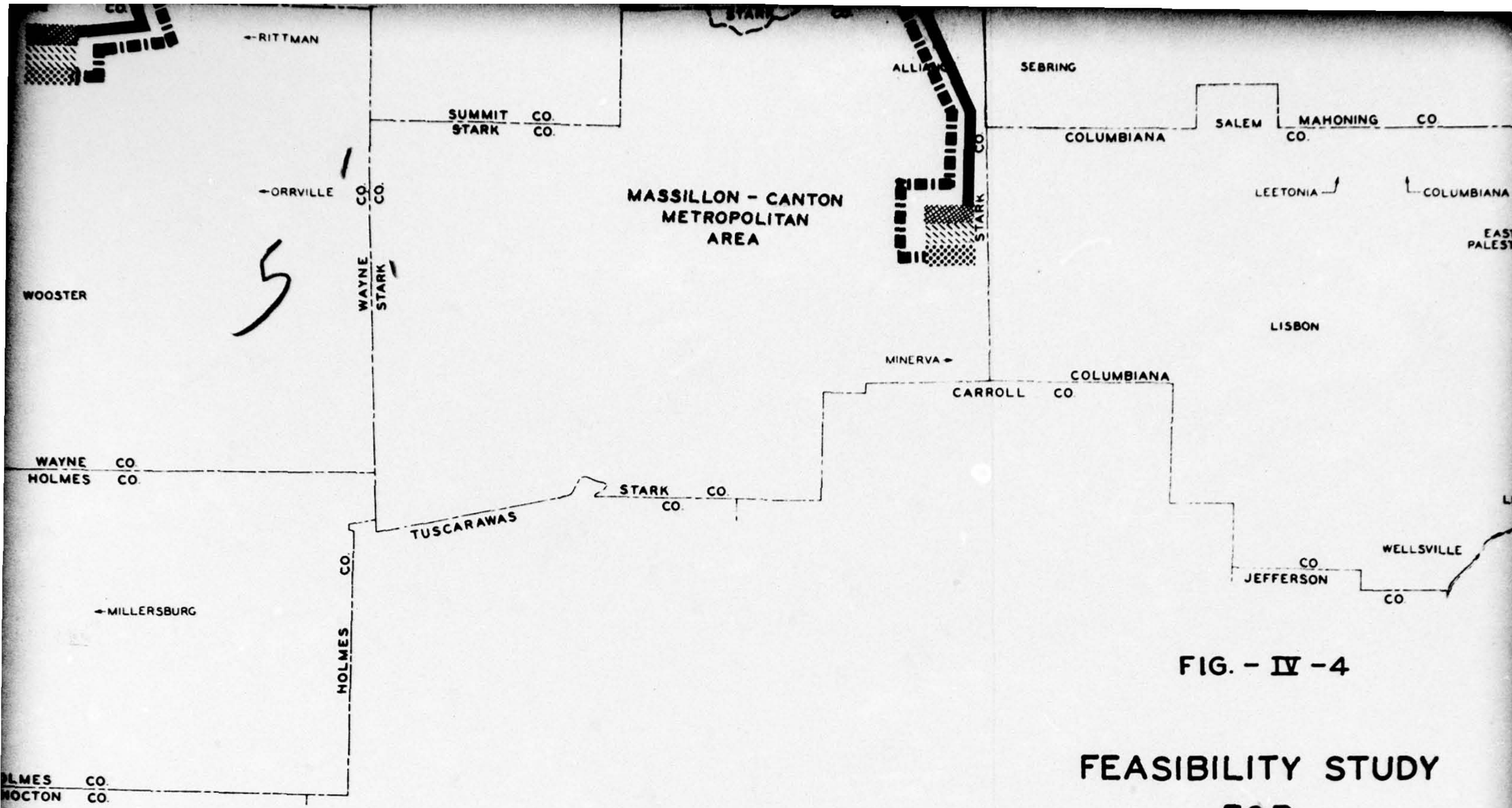


FIG. - IV -4

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT PRO

STORM RUNOFF SYSTEM NOT SHOWN, HOWEVER IT IS THE SAME AS L-1.

L-2

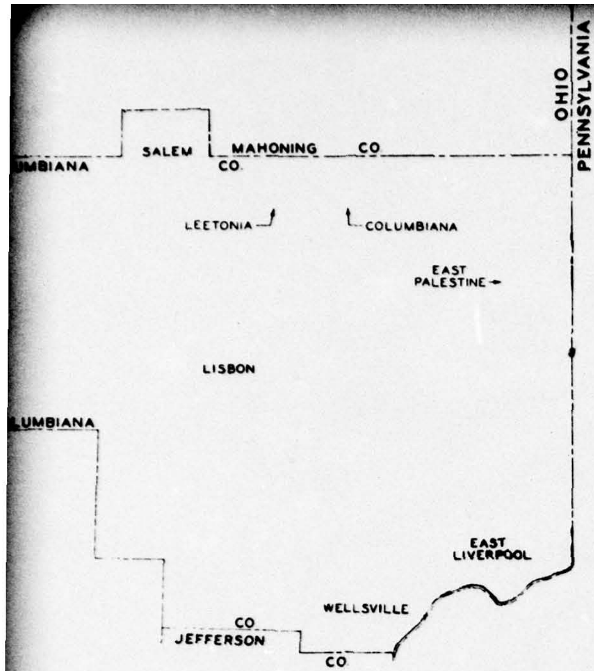
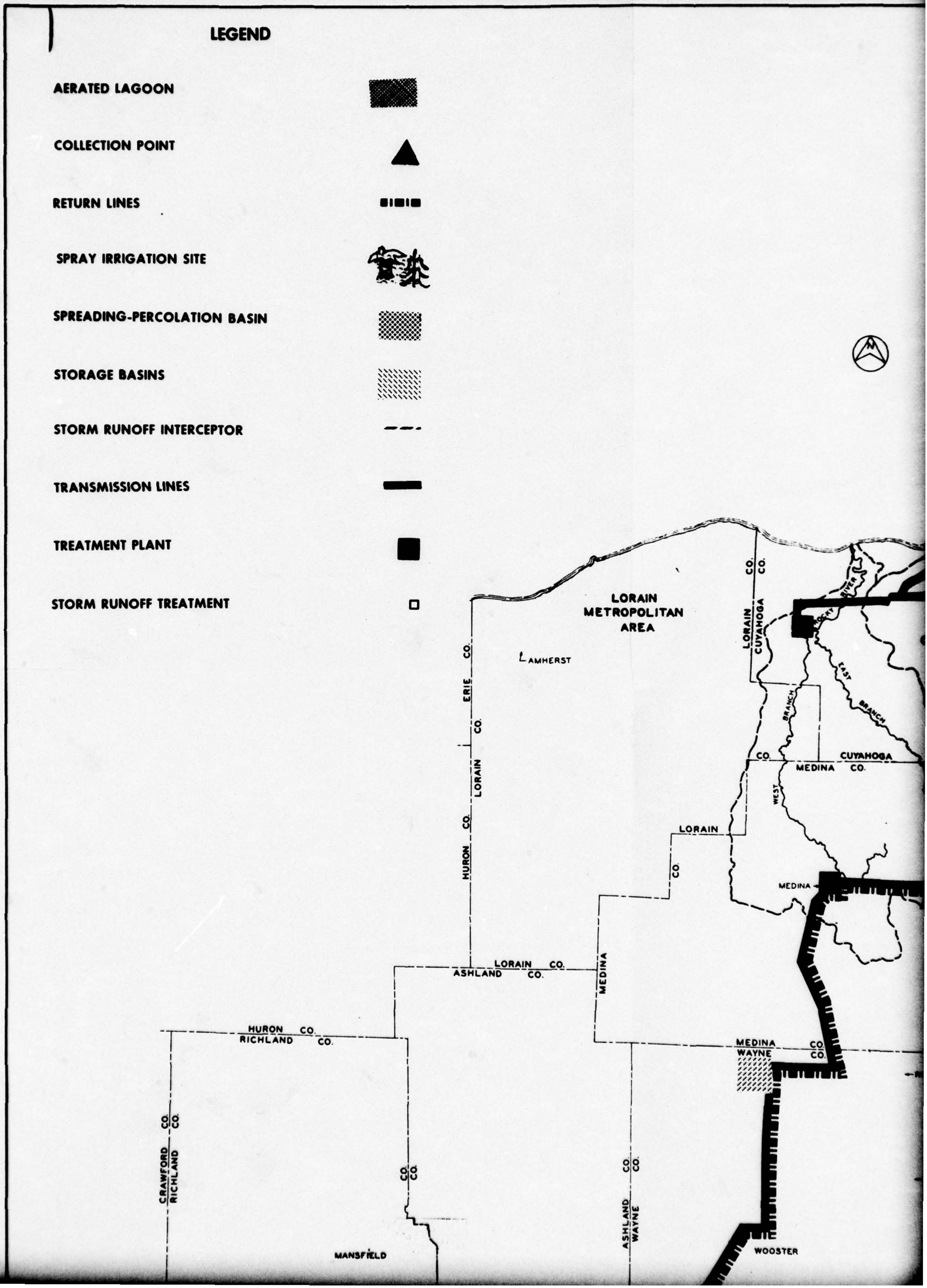


FIG. - IV -4

FEASIBILITY STUDY
FOR
TER MANAGEMENT PROGRAM

L-2

6


LEGEND
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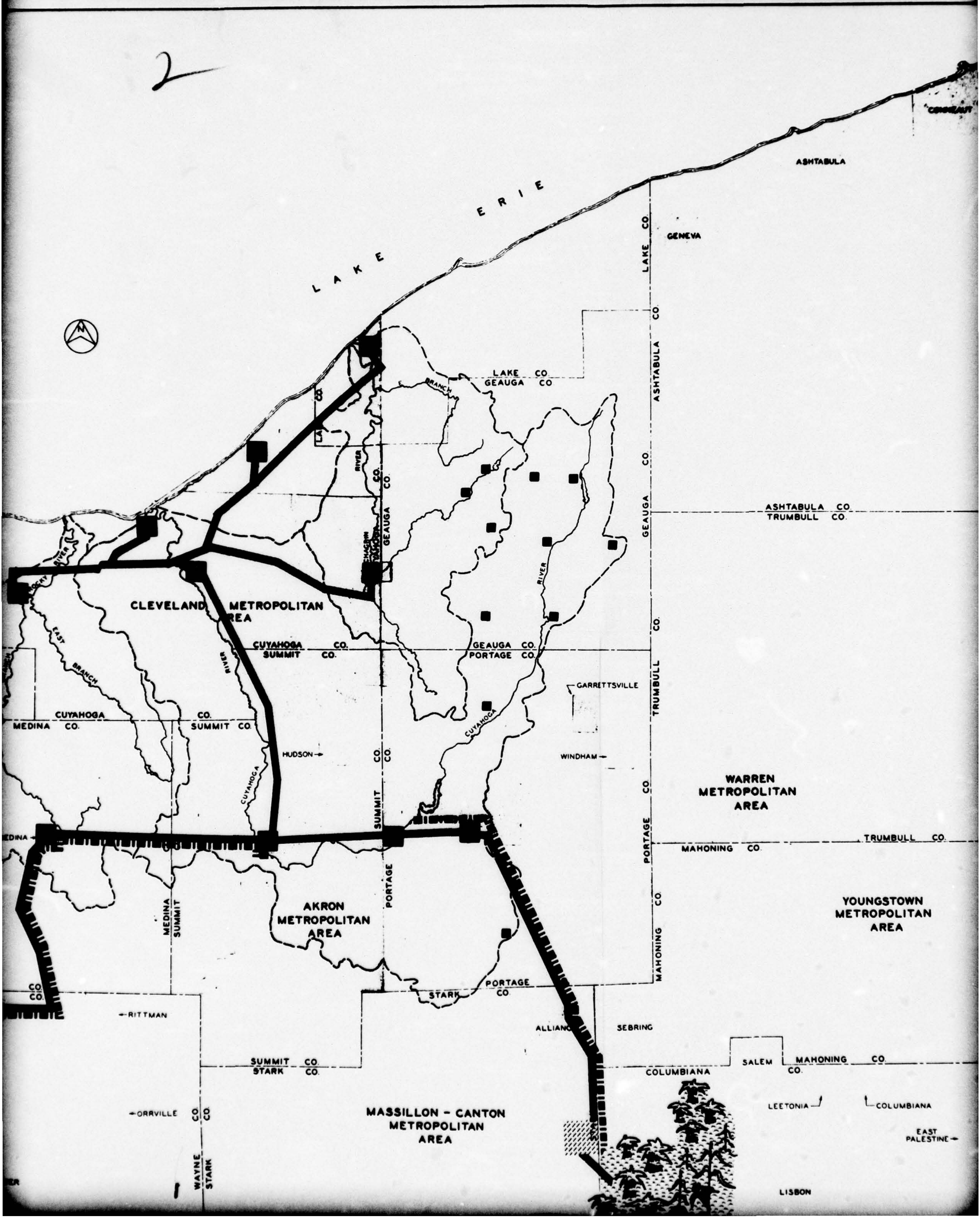
COLLECTION POINT
RETURN LINES
SPRAY IRRIGATION SITE
SPREADING-PERCOLATION BASIN
STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
ERIE CO.
LORAIN CO.
HURON CO.
LORAIN CO.
CUYAHOGA CO.
ROCKY RIVER
EAST BRANCH
BRANCH
WEST
CUYAHOGA CO.
MEDINA CO.
LORAIN CO.
MEDINA
LORAIN CO.
ASHLAND CO.
MEDINA
HURON CO.
RICHLAND CO.
MEDINA CO.
WAYNE CO.
CRAWFORD CO.
RICHLAND CO.
ASHLAND CO.
WAYNE CO.
MANSFIELD
WOOSTER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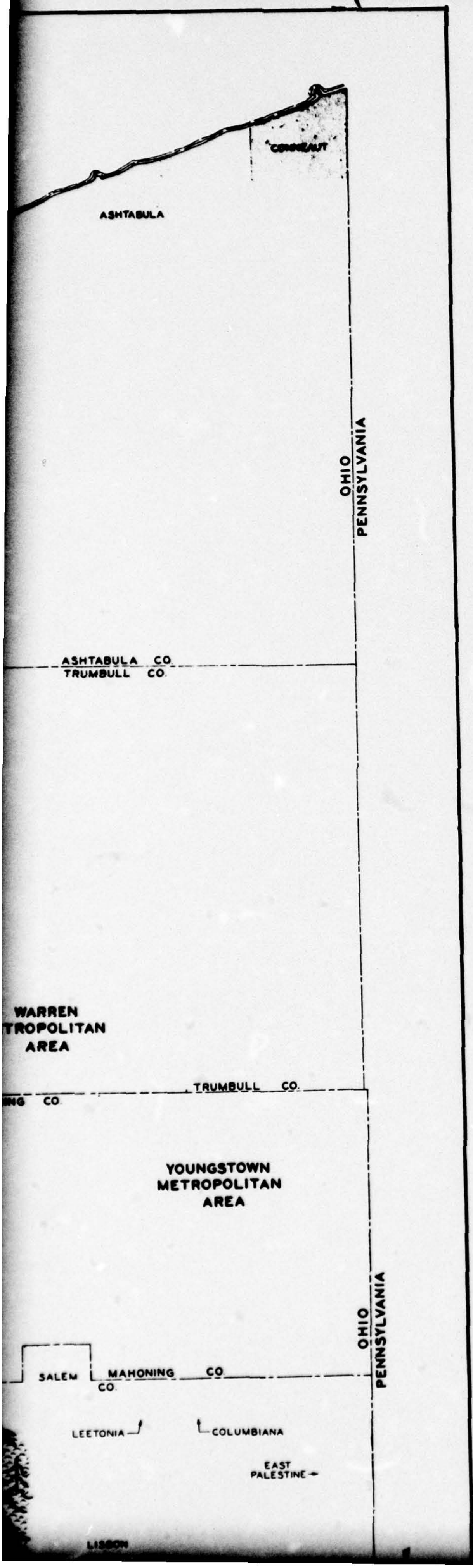
LAKE ERIE
ASHTABULA
GENEVA
LAKE CO.
ASHTABULA CO.
LAKE CO.
GEAUGA CO.
GEAUGA CO.
ASHTABULA CO.
TRUMBULL CO.
CLEVELAND METROPOLITAN AREA
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
GARRETTSVILLE
TRUMBULL CO.
CUYAHOGA CO.
MEDINA CO.
SUMMIT CO.
HUDSON
WINDHAM
SUMMIT CO.
PORTAGE CO.
WARREN METROPOLITAN AREA
TRUMBULL CO.
MAHONING CO.
AKRON METROPOLITAN AREA
MEDINA
SUMMIT
MAHONING CO.
YOUNGSTOWN METROPOLITAN AREA
PORTAGE
STARK CO.
RITTMAN
SEBRING
SUMMIT CO.
STARK CO.
SALEM
MAHONING CO.
COLUMBIANA CO.
MASSILLON - CANTON METROPOLITAN AREA
ORRVILLE
WAYNE CO.
STARK CO.
LEETONIA
COLUMBIANA
EAST PALESTINE
LISBON
CUYAHOGA
RIVER
EAST BRANCH
BRANCH

3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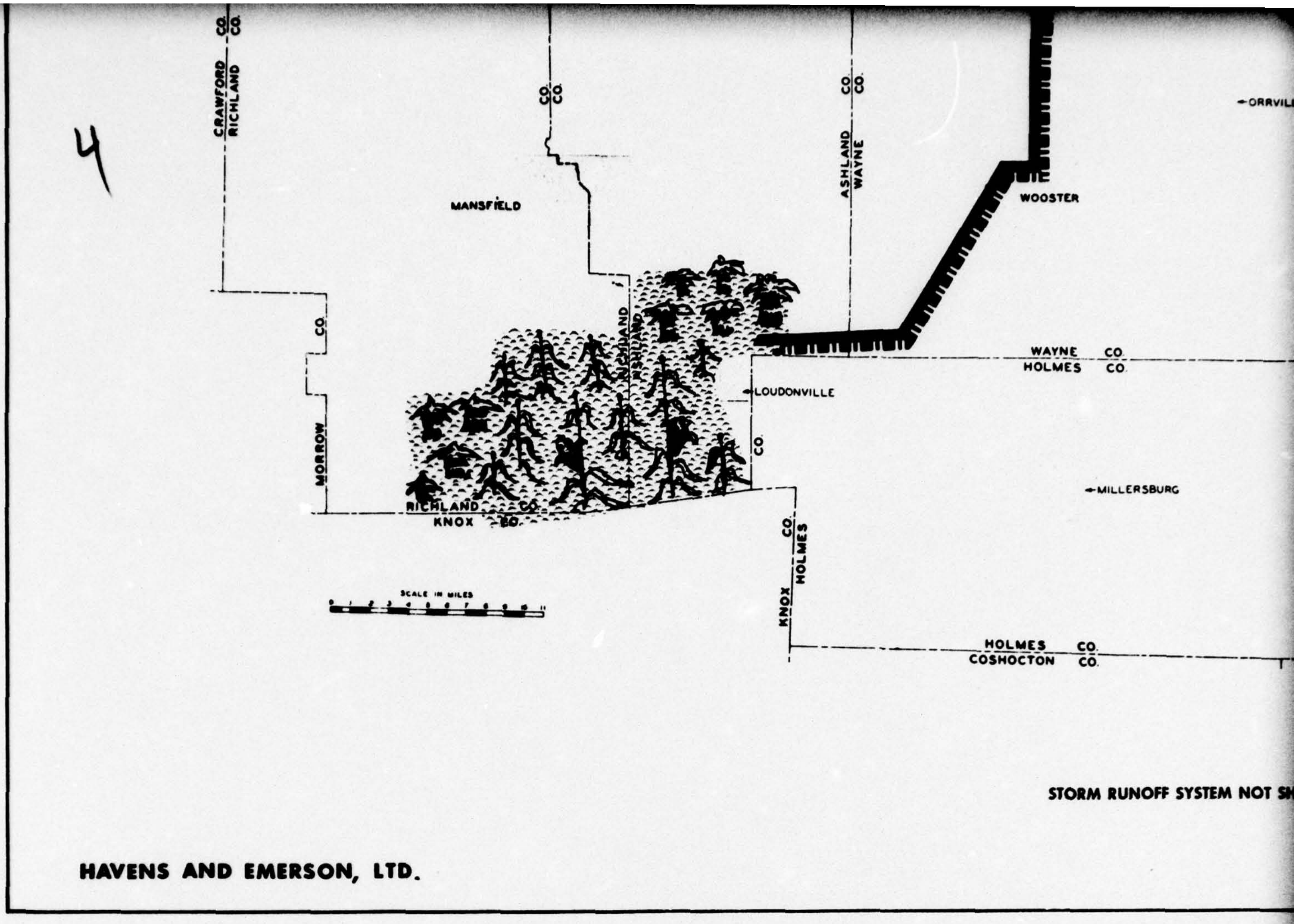
PENNSYLVANIA
ASHTABULA CO.
TRUMBULL CO.
WARREN
TROPOLITAN
AREA
TRUMBULL CO.
NG CO.
YOUNGSTOWN
METROPOLITAN
AREA
OHIO
PENNSYLVANIA
SALEM
MAHONING CO.
CO.
LEETONIA
COLUMBIANA
EAST
PALESTINE
LISBON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CRAWFORD CO.
RICHLAND CO.
MANSFIELD
ASHLAND CO.
WAYNE CO.
WOOSTER
MORROW CO.
RICHLAND CO.
KNOX CO.
LOUDONVILLE
WAYNE CO.
HOLMES CO.
MILLERSBURG
KNOX CO.
HOLMES
HOLMES CO.
COSHOCTON CO.
SCALE IN MILES
STORM RUNOFF SYSTEM NOT
HAVENS AND EMERSON, LTD.

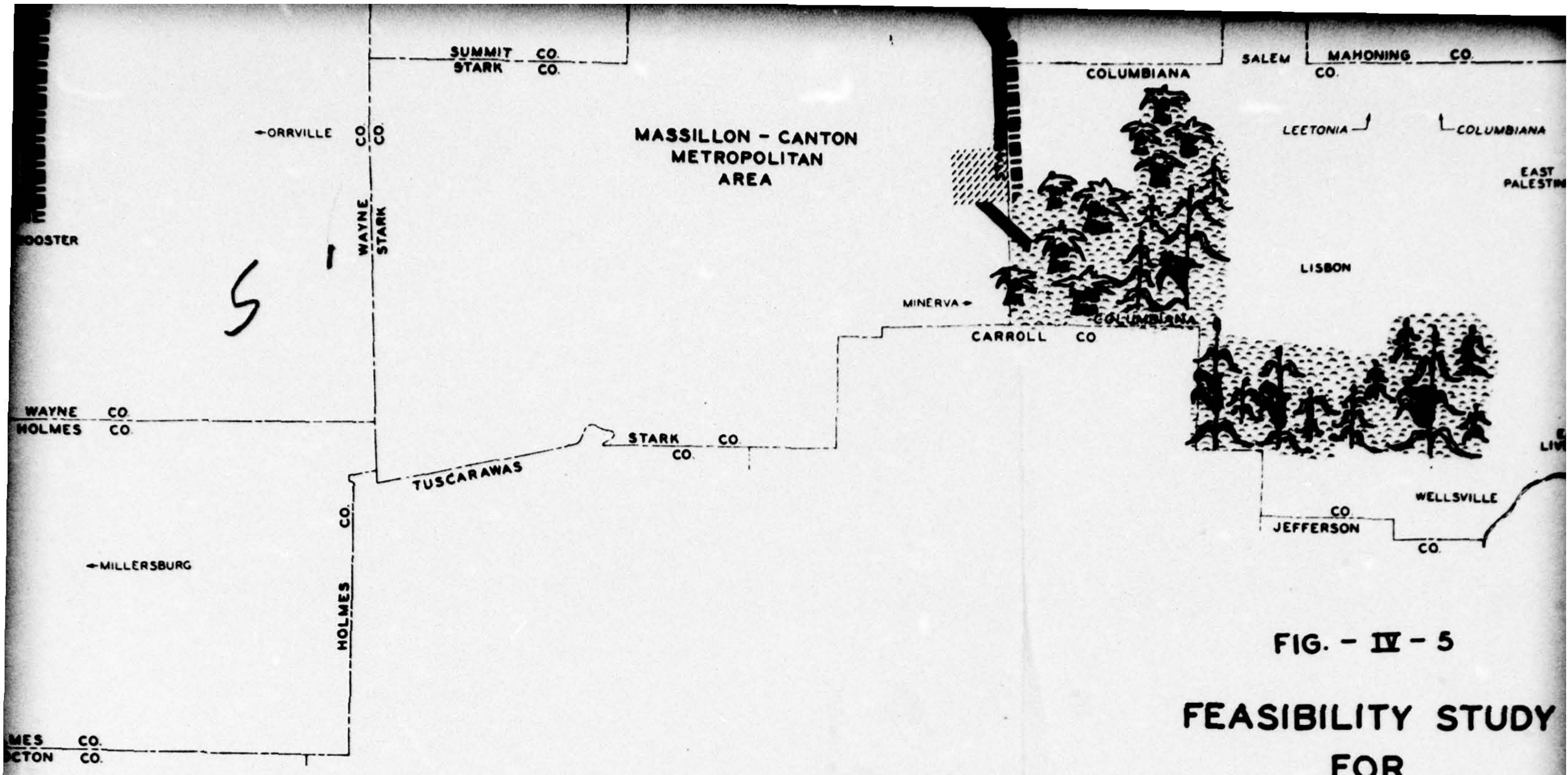


FIG. - IV - 5

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT

STORM RUNOFF SYSTEM NOT SHOWN, HOWEVER IT IS THE SAME AS W-1.

C-1

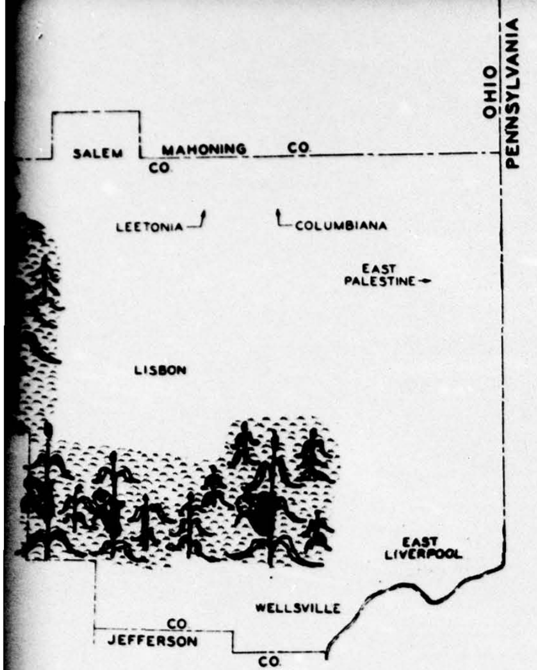
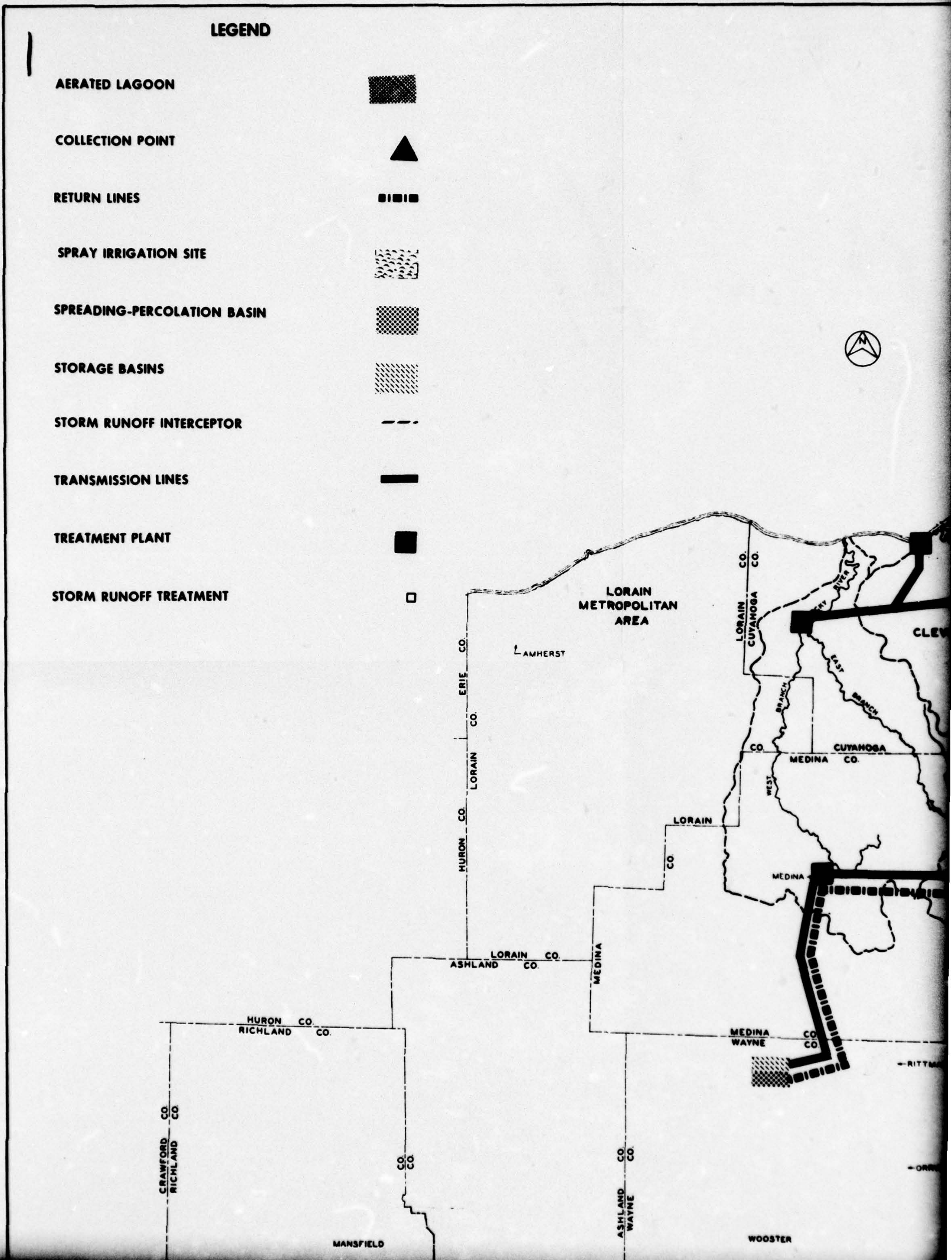


FIG. - IV - 5

FEASIBILITY STUDY
FOR
TER MANAGEMENT PROGRAM

C-1

6



LEGEND
AERATED LAGOON
COLLECTION POINT
RETURN LINES
SPRAY IRRIGATION SITE
SPREADING-PERCOLATION BASIN
STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
ERIE CO.
LORAIN CO.
HURON CO.
LORAIN CO.
CUYAHOGA CO.
EAST BRANCH
WEST BRANCH
LORAIN CO.
MEDINA CO.
CUYAHOGA
LORAIN
CO.
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ASHLAND CO.
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HURON CO.
RICHLAND CO.
MEDINA CO.
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CRAWFORD CO.
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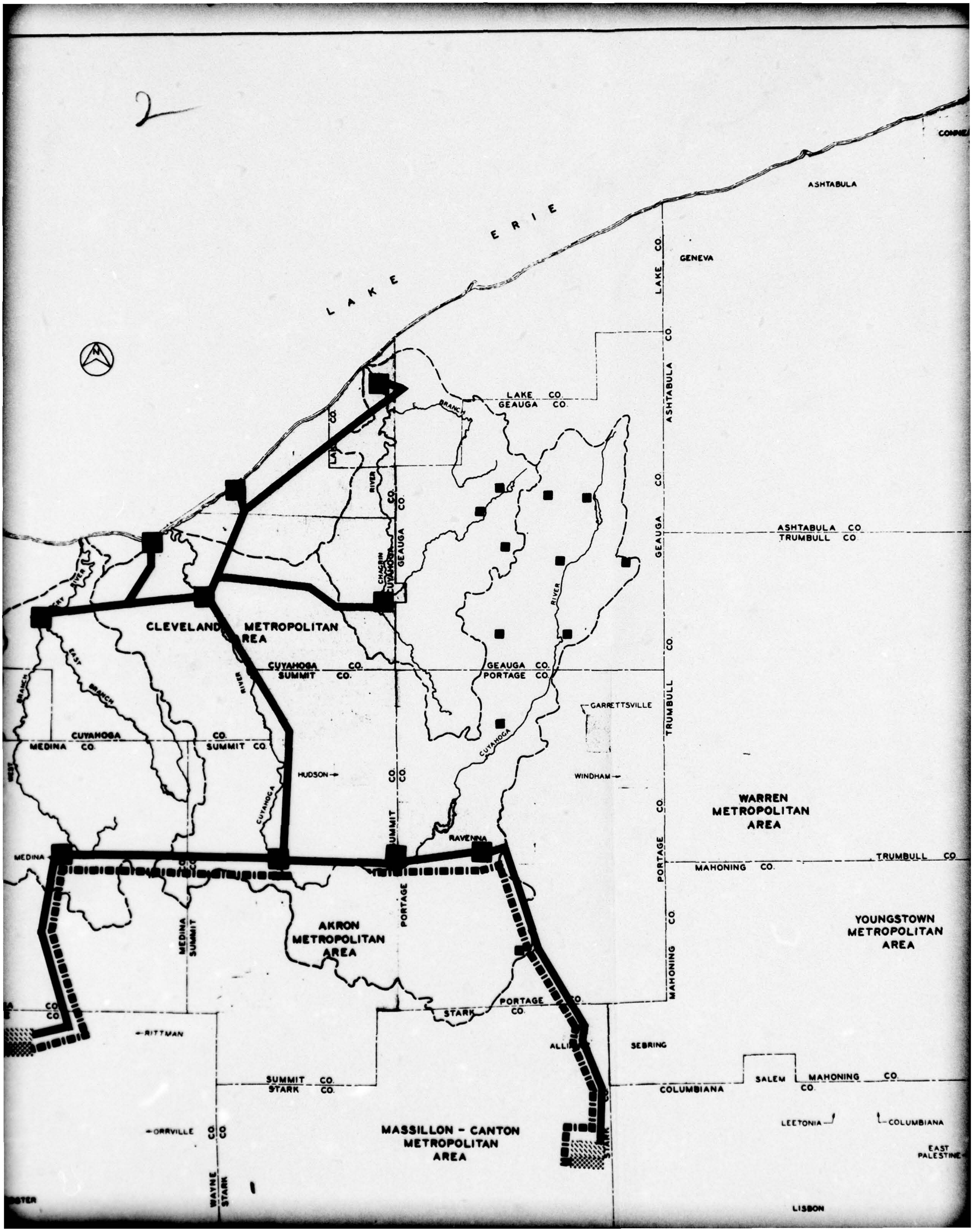
ASHLAND CO.
WAYNE CO.
MANSFIELD
WOOSTER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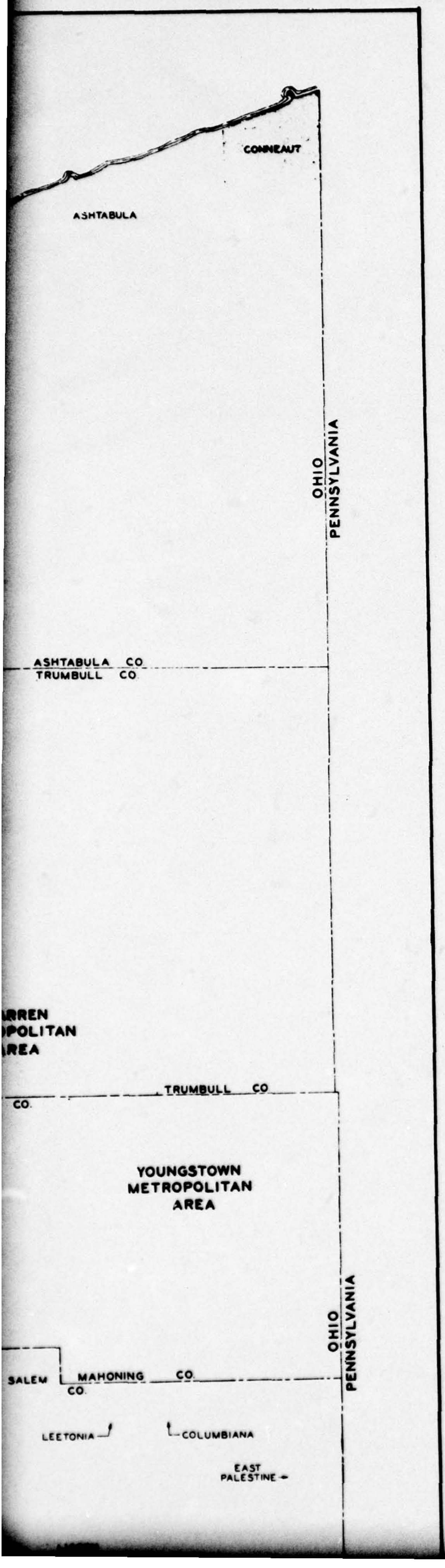
GENEVA
LAKE CO.
ASHTABULA CO.
GEAUGA CO.
TRUMBULL CO.
ASHTABULA CO.
TRUMBULL CO.
LAKE CO.
GEAUGA CO.
E. BRANCH
CHAGRIN RIVER
CUYAHOGA CO.
GEAUGA CO.
CLEVELAND METROPOLITAN AREA
EAST BRANCH
BRANCH
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
RIVER
GARRETTSVILLE
CUYAHOGA
CUYAHOGA CO.
MEDINA CO.
SUMMIT CO.
HUDSON
SUMMIT CO.
PORTAGE CO.
WINDHAM
WARREN METROPOLITAN AREA
PORTAGE CO.
TRUMBULL CO.
MAHONING CO.
MEDINA
RAVENNA
AKRON METROPOLITAN AREA
MEDINA SUMMIT
YOUNGSTOWN METROPOLITAN AREA
MAHONING CO.
PORTAGE CO.
STARK CO.
RITTMAN
SEBRING
SUMMIT CO.
STARK CO.
SALEM
MAHONING CO.
COLUMBIANA CO.
LEETONIA
COLUMBIANA
ORRVILLE
MASSILLON - CANTON METROPOLITAN AREA
WAYNE CO.
STARK CO.
STARK
EAST PALESTINE
LISBON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OHIO
PENNSYLVANIA
ASHTABULA CO.
TRUMBULL CO.
ARREN
POLITAN
AREA
TRUMBULL CO
CO.
YOUNGSTOWN
METROPOLITAN
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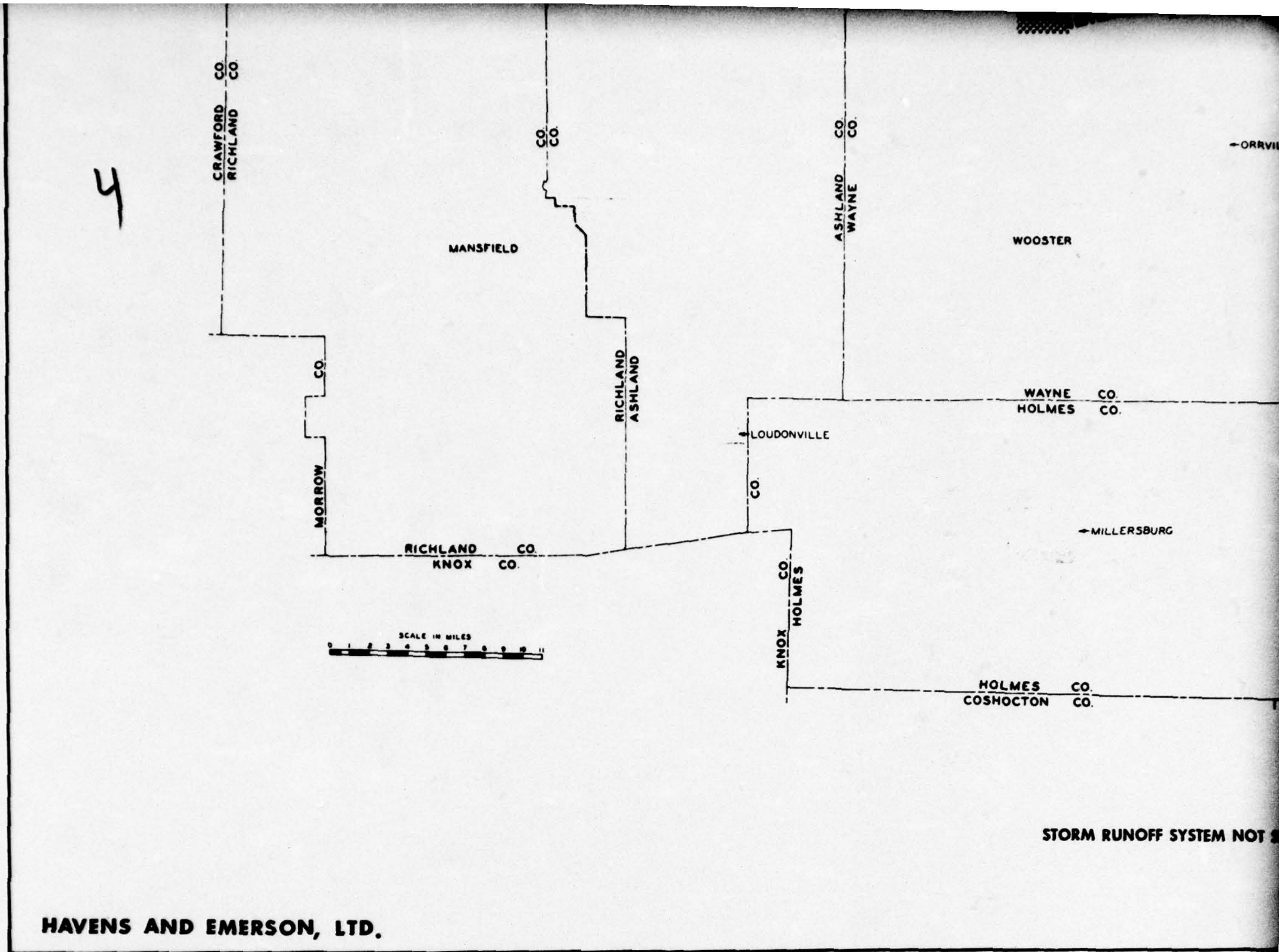
4
CRAWFORD CO
RICHLAND CO
CO
CO
ASHLAND CO
WAYNE CO
ORRVI
MANSFIELD
WOOSTER
MORROW CO
RICHLAND
ASHLAND
WAYNE CO.
HOLMES CO.
LOUDONVILLE
CO.
MILLERSBURG
RICHLAND CO.
KNOX CO.
KNOX CO.
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SCALE IN MILES
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COSHOCTON CO.
STORM RUNOFF SYSTEM NOT
HAVENS AND EMERSON, LTD.

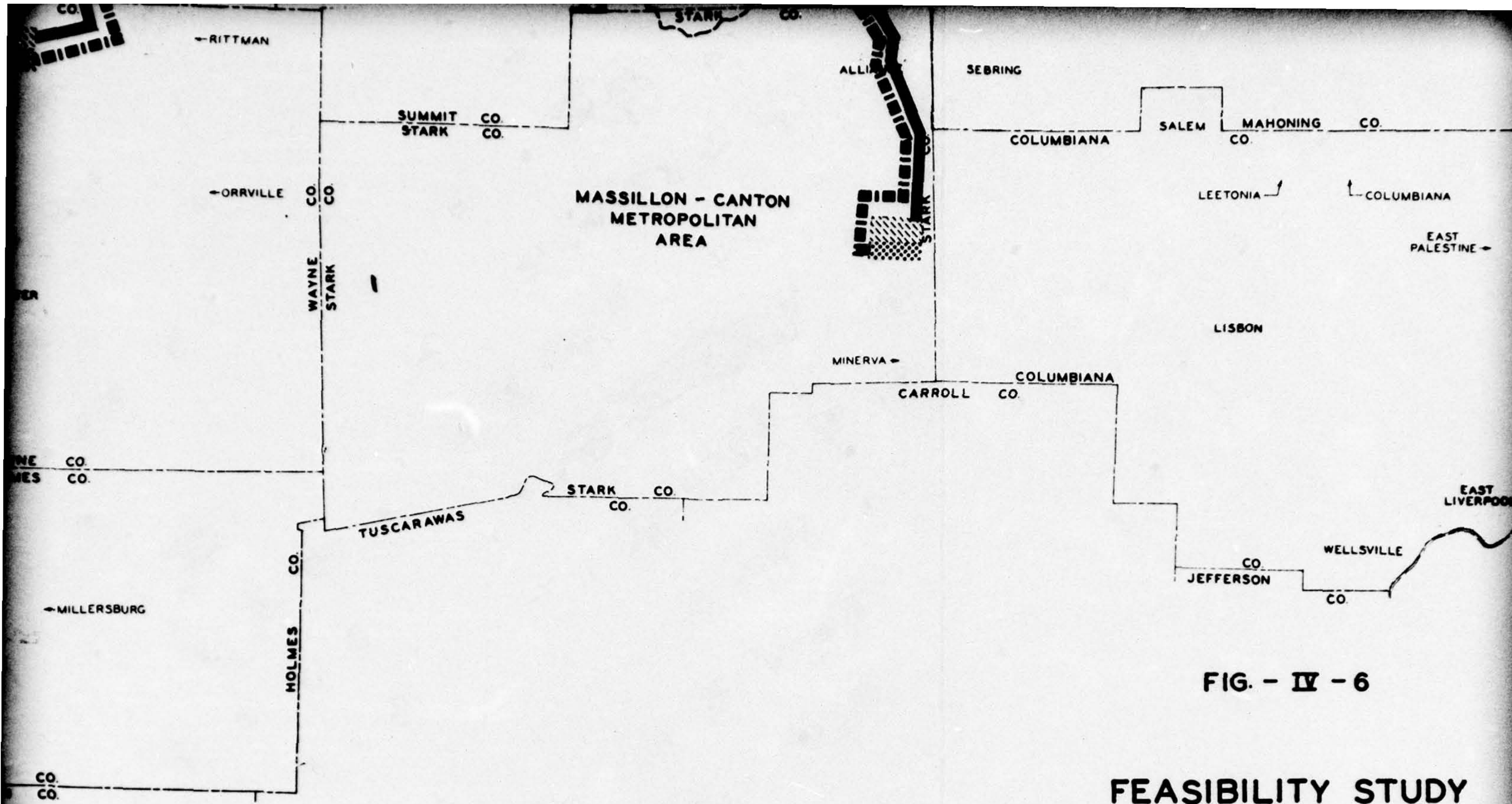


FIG. - IV - 6

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT PR

5

STORM RUNOFF SYSTEM NOT SHOWN, HOWEVER IT IS THE SAME AS W-1.

C-2

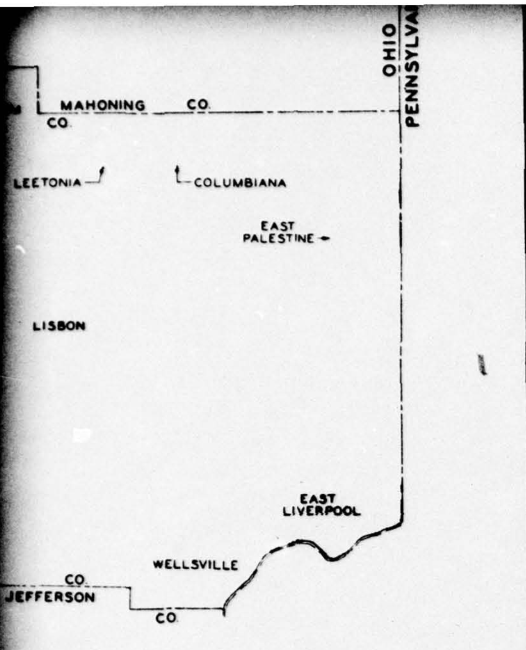
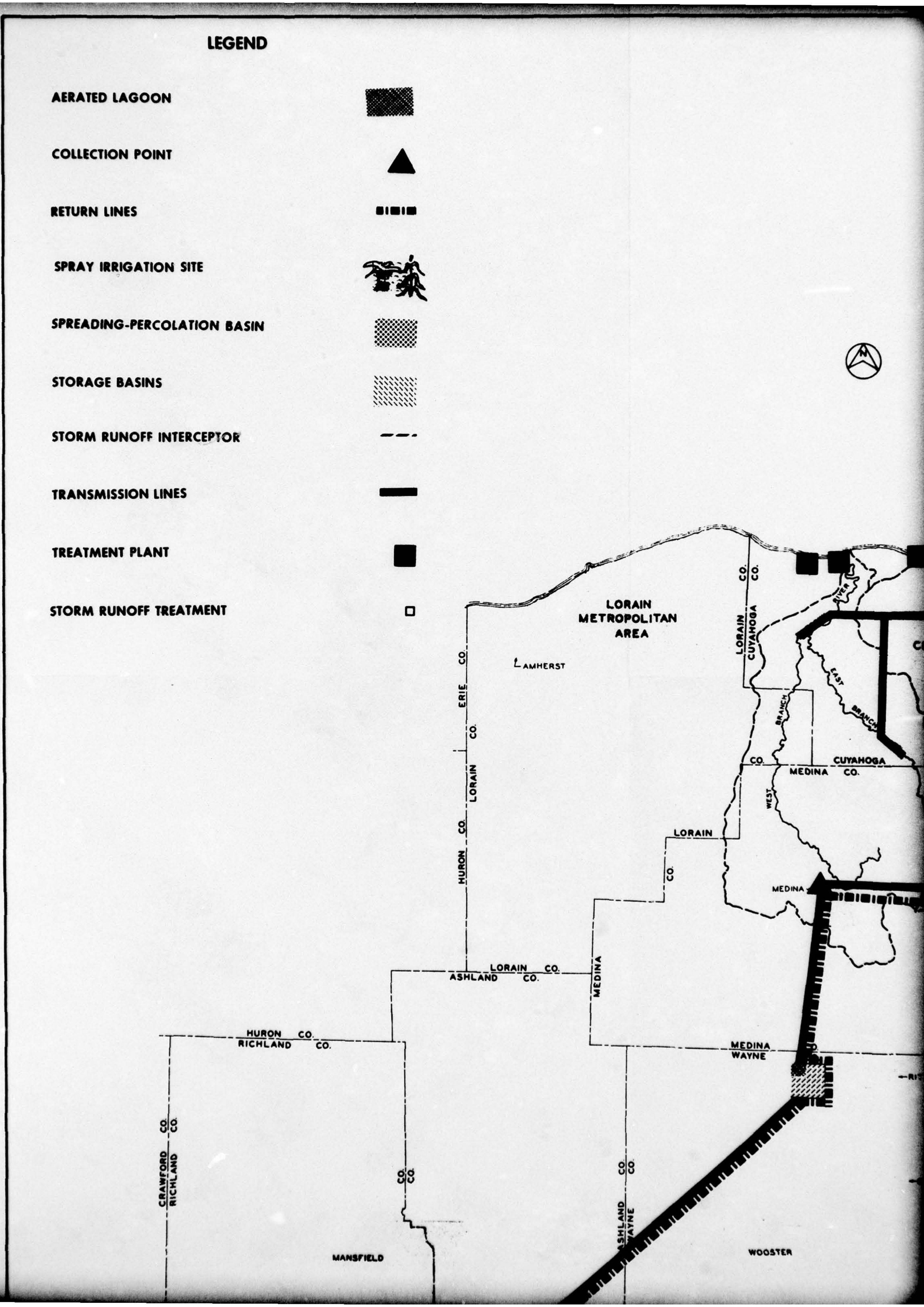


FIG. - IV - 6

SIBILITY STUDY
FOR
MANAGEMENT PROGRAM

C-2

6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SPREADING-PERCOLATION BASIN
STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
ERIE CO.
LORAIN CO.
HURON CO.
LORAIN CO.
CUYAHOGA CO.
CUYAHOGA CO.
MEDINA CO.
EAST BRANCH
WEST BRANCH
RIVER
LORAIN CO.
MEDINA
LORAIN CO.
ASHLAND CO.
MEDINA
HURON CO.
RICHLAND CO.
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WAYNE
CRAWFORD CO.
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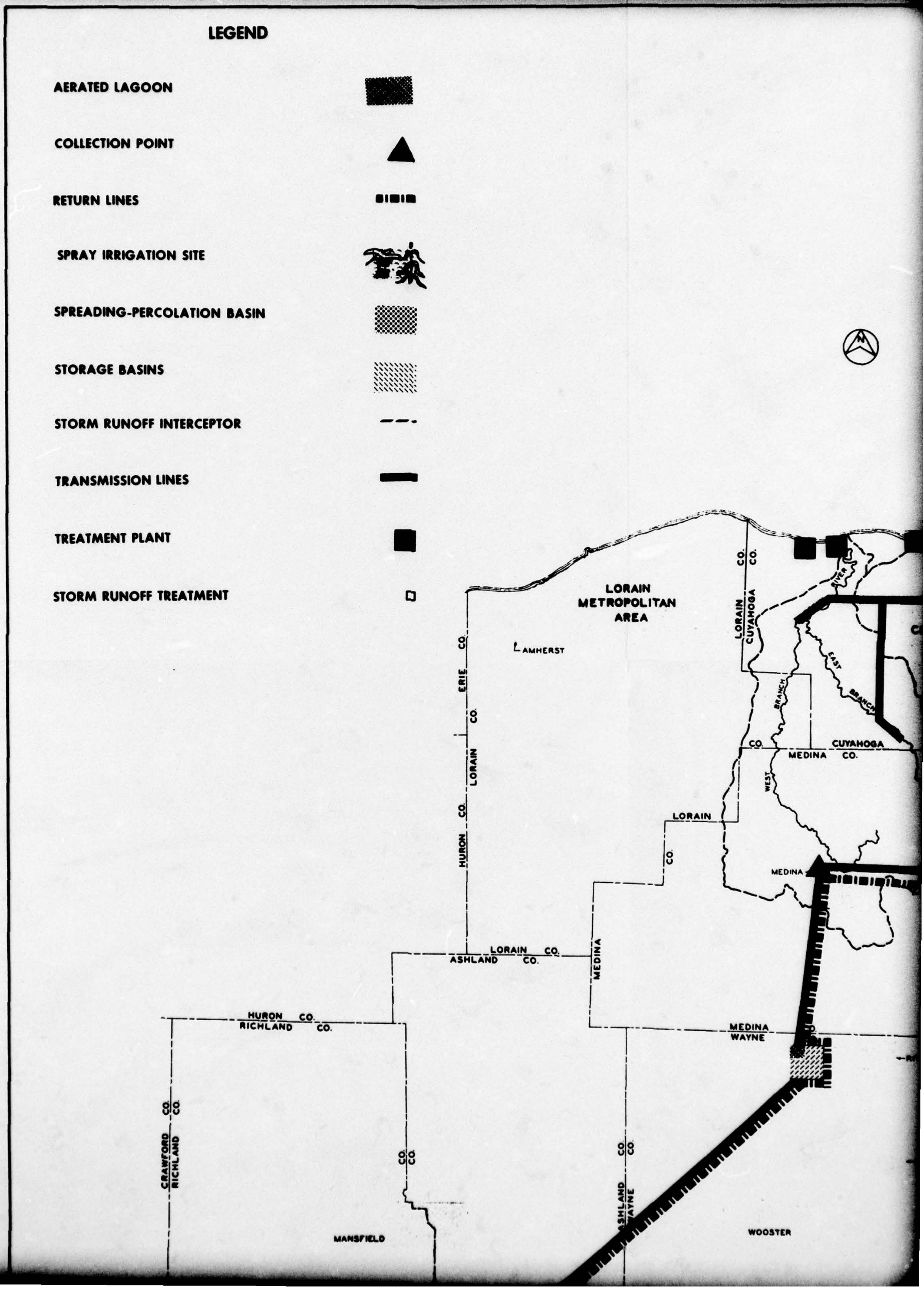
ASHLAND CO.
WAYNE CO.
MANSFIELD
WOOSTER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STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
ERIE CO.
LORAIN CO.
HURON CO.
LORAIN CO.
CUYAHOGA CO.
CUYAHOGA CO.
MEDINA CO.
LORAIN CO.
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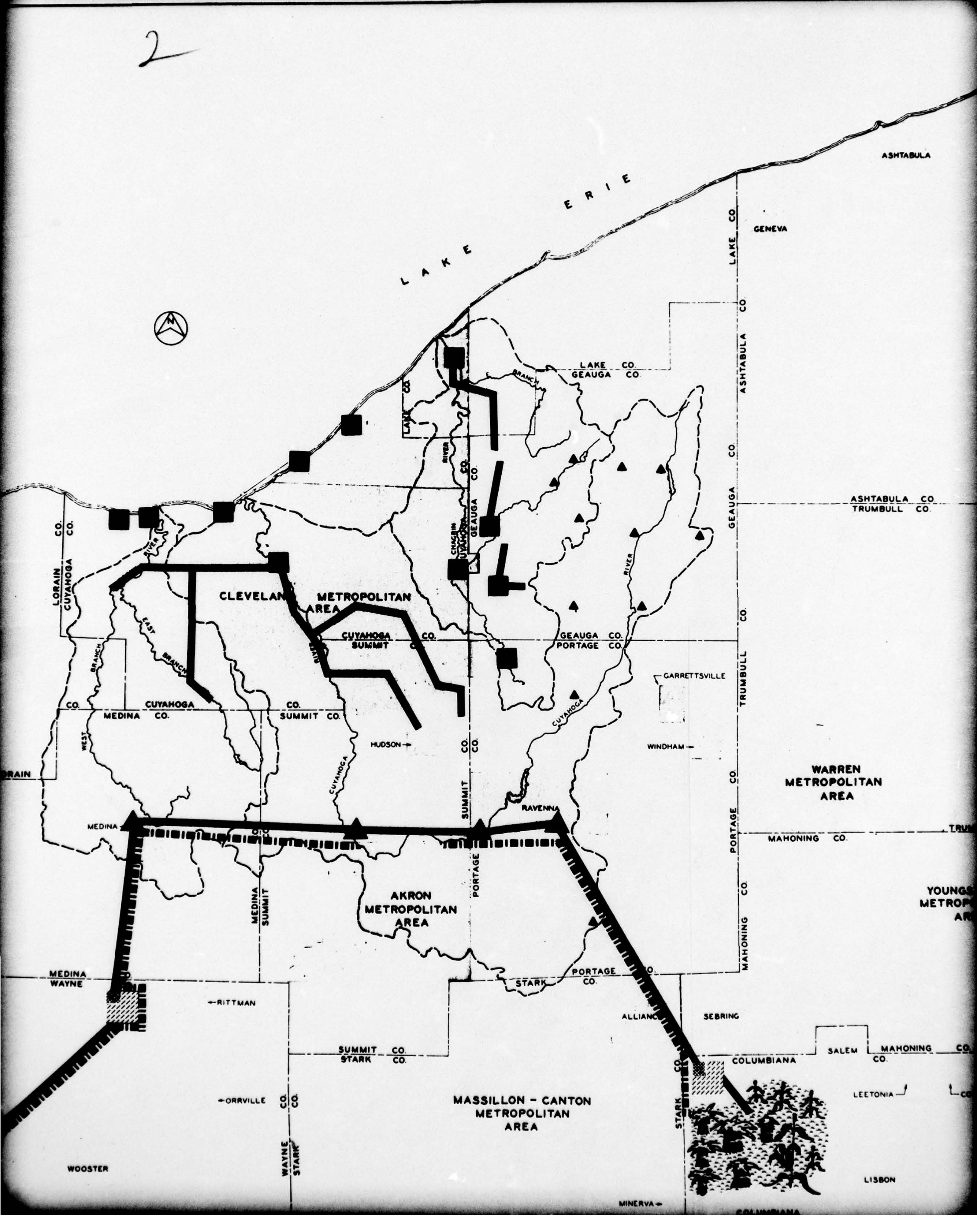
LORAIN CO.
ASHLAND CO.
MEDINA
HURON CO.
RICHLAND CO.
MEDINA
WAYNE
CRAWFORD CO.
RICHLAND CO.
ASHLAND CO.
WAYNE CO.
MANSFIELD
WOOSTER
RIVER
EAST BRANCH
WEST BRANCH

2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GENEVA
LAKE CO.
ASHTABULA CO.
LAKE CO.
GEAUGA CO.
ASHTABULA CO.
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GEAUGA CO.
TRUMBULL CO.
LORAIN CO.
CUYAHOGA CO.
CLEVELAND METROPOLITAN AREA
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
GARRETTSVILLE
CO. CUYAHOGA
MEDINA CO.
CO. SUMMIT CO.
HUDSON
WINDHAM
SUMMIT CO.
PORTAGE CO.
WARREN METROPOLITAN AREA
MEDINA
RAVENNA
MAHONING CO.
AKRON METROPOLITAN AREA
MEDINA SUMMIT
PORTAGE CO.
MAHONING CO.
MEDINA WAYNE
PORTAGE CO.
STARK CO.
RITTMAN
ALLIANCE
SEBRING
SUMMIT CO.
STARK CO.
COLUMBIANA
SALEM
MAHONING CO.
ORRVILLE
MASSILLON - CANTON METROPOLITAN AREA
LEETONIA
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WAYNE STARK
WOOSTER
LISBON
MINERVA
COLUMBIANA

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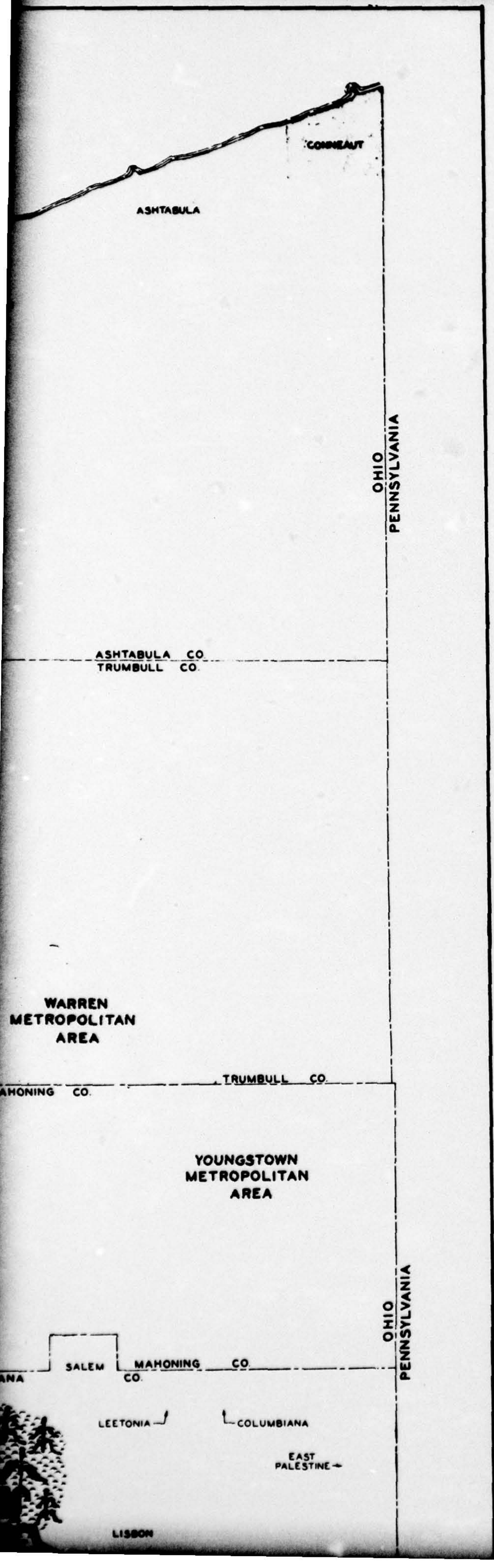
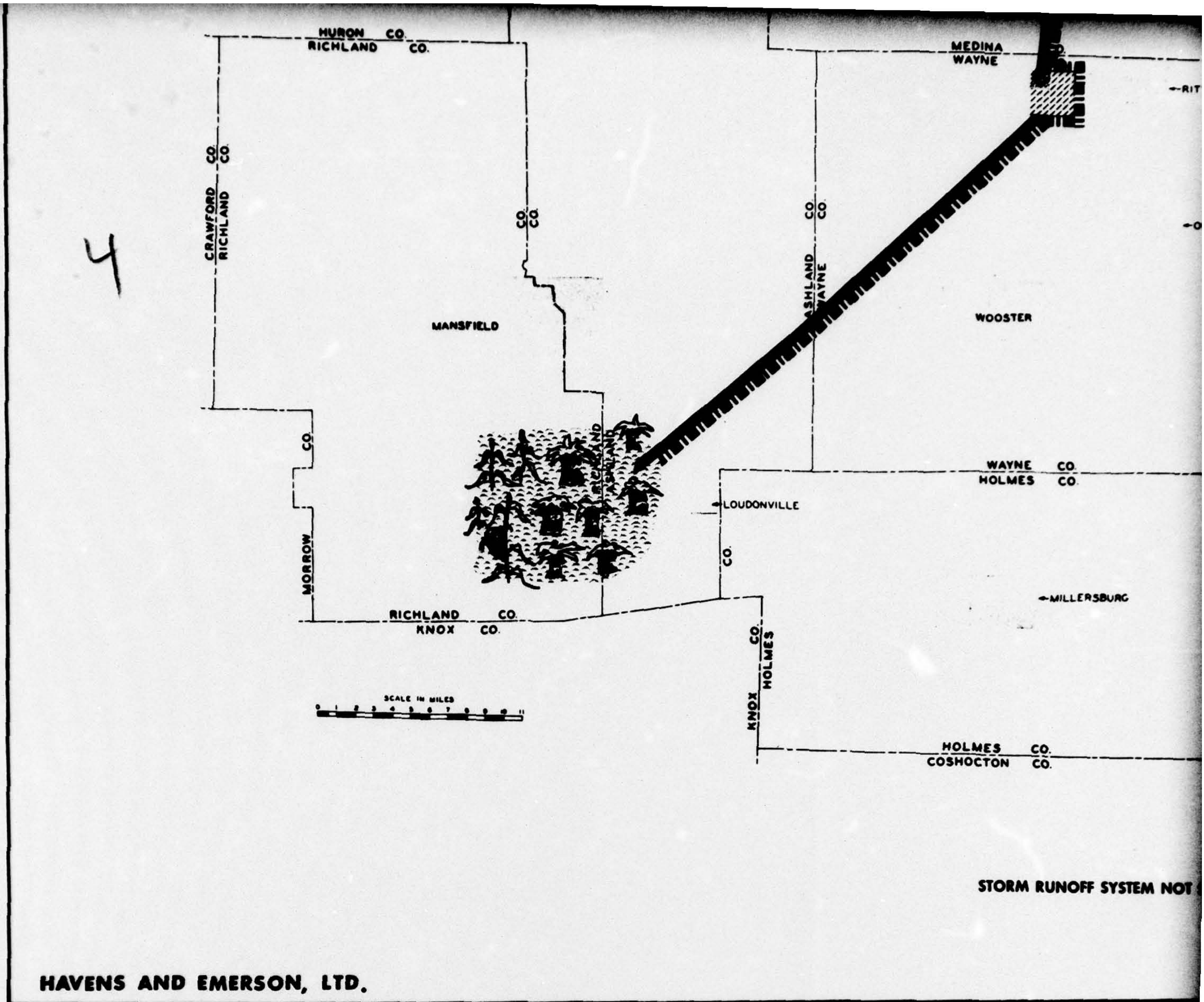


CONNEAUT
ASHTABULA
OHIO
PENNSYLVANIA
ASHTABULA CO.
TRUMBULL CO.
WARREN
METROPOLITAN
AREA
TRUMBULL CO.
AHONING CO.
YOUNGSTOWN
METROPOLITAN
AREA
OHIO
PENNSYLVANIA
SALEM
MAHONING CO.
CO.
LEETONIA
COLUMBIANA
EAST
PALESTINE
LISBON

4


HURON CO.
RICHLAND CO.
MEDINA
WAYNE
CRAWFORD CO.
RICHLAND CO.
ASHLAND CO.
WAYNE CO.
MANSFIELD
WOOSTER
RICHLAND
ASHLAND
LOUDONVILLE
WAYNE CO.
HOLMES CO.
MORROW CO.
MILLERSBURG
RICHLAND CO.
KNOX CO.
KNOX CO.
HOLMES CO.
SCALE IN MILES
HOLMES CO.
COSHOCTON CO.
STORM RUNOFF SYSTEM NOT
HAVENS AND EMERSON, LTD.

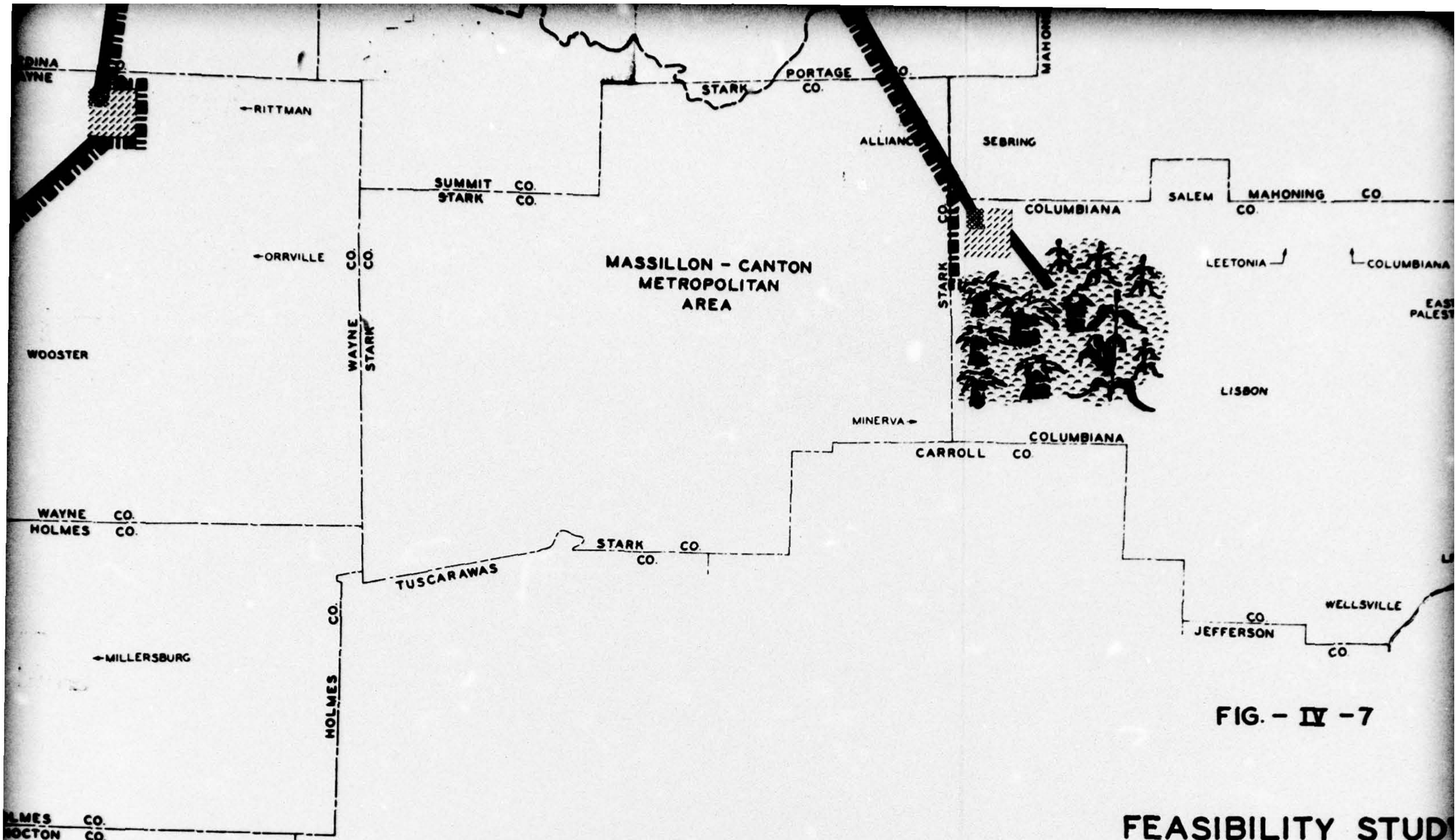


FIG. - IV -7

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT

5

STORM RUNOFF SYSTEM NOT SHOWN, HOWEVER IT IS THE SAME AS W-1.

C-3

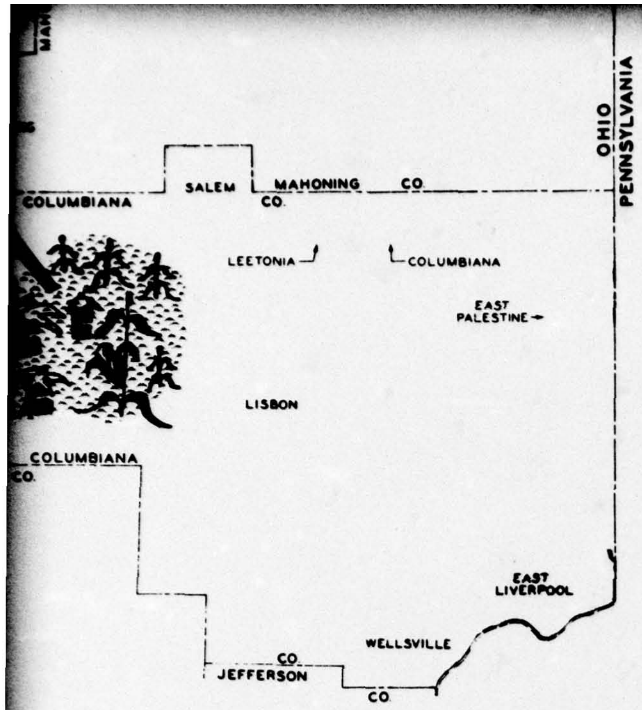
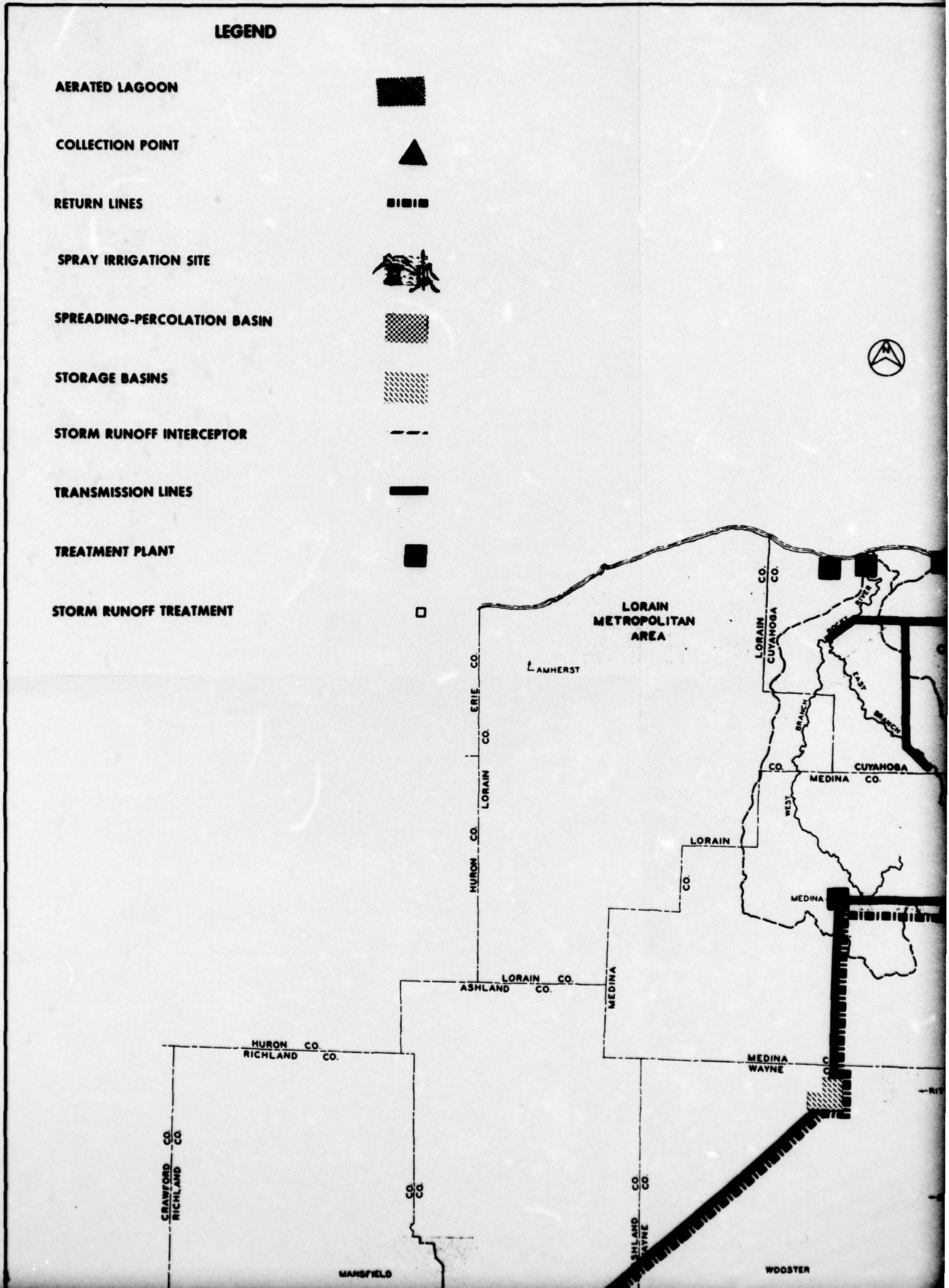


FIG. - IV -7

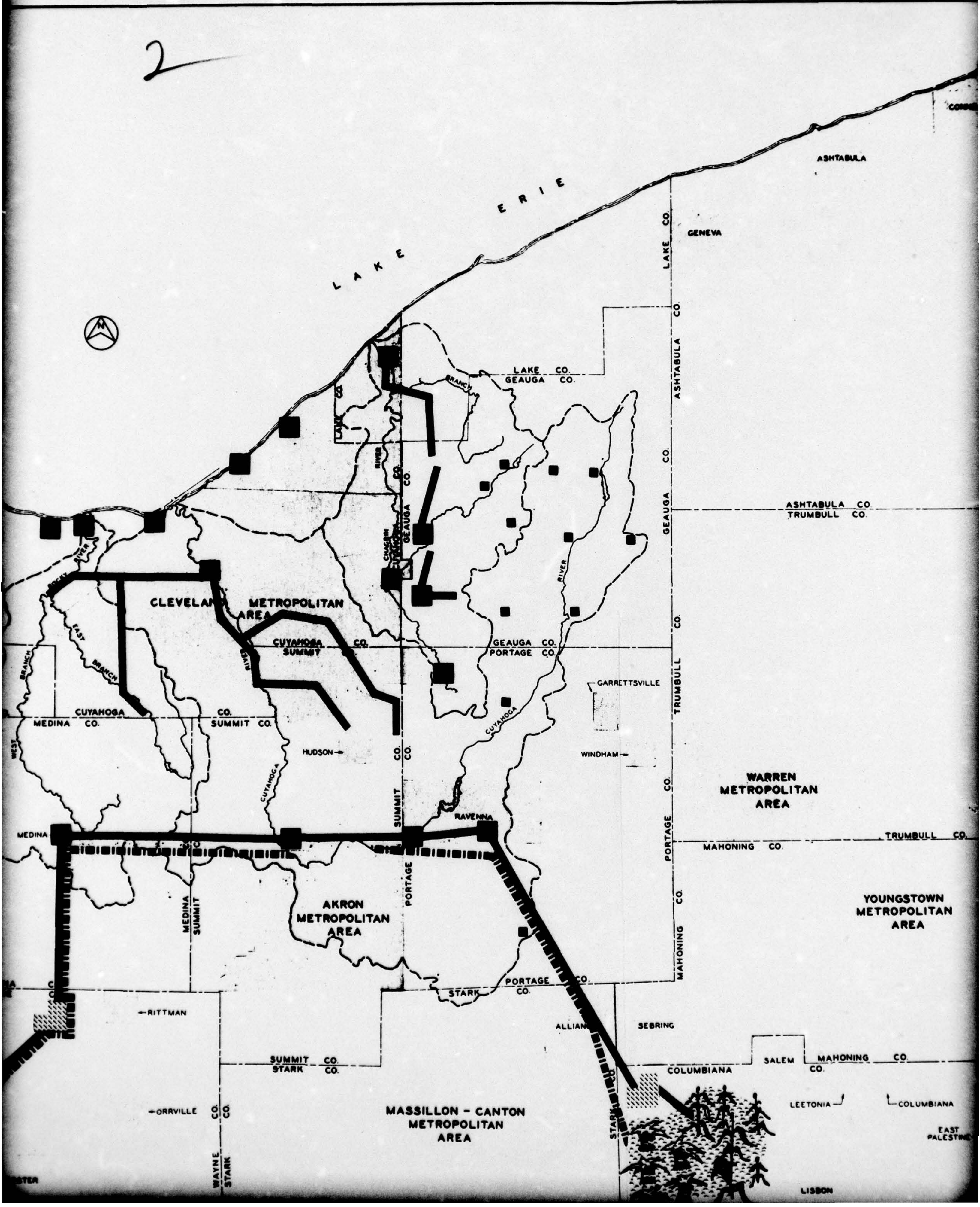
FEASIBILITY STUDY
FOR
STEWATER MANAGEMENT PROGRAM

C-3

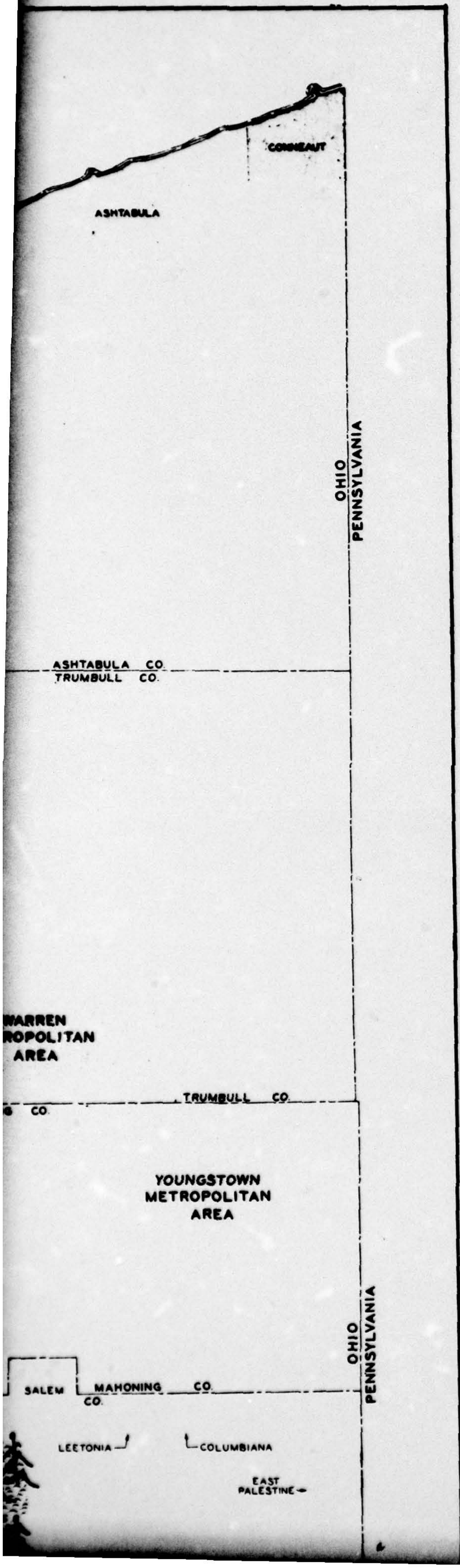
6

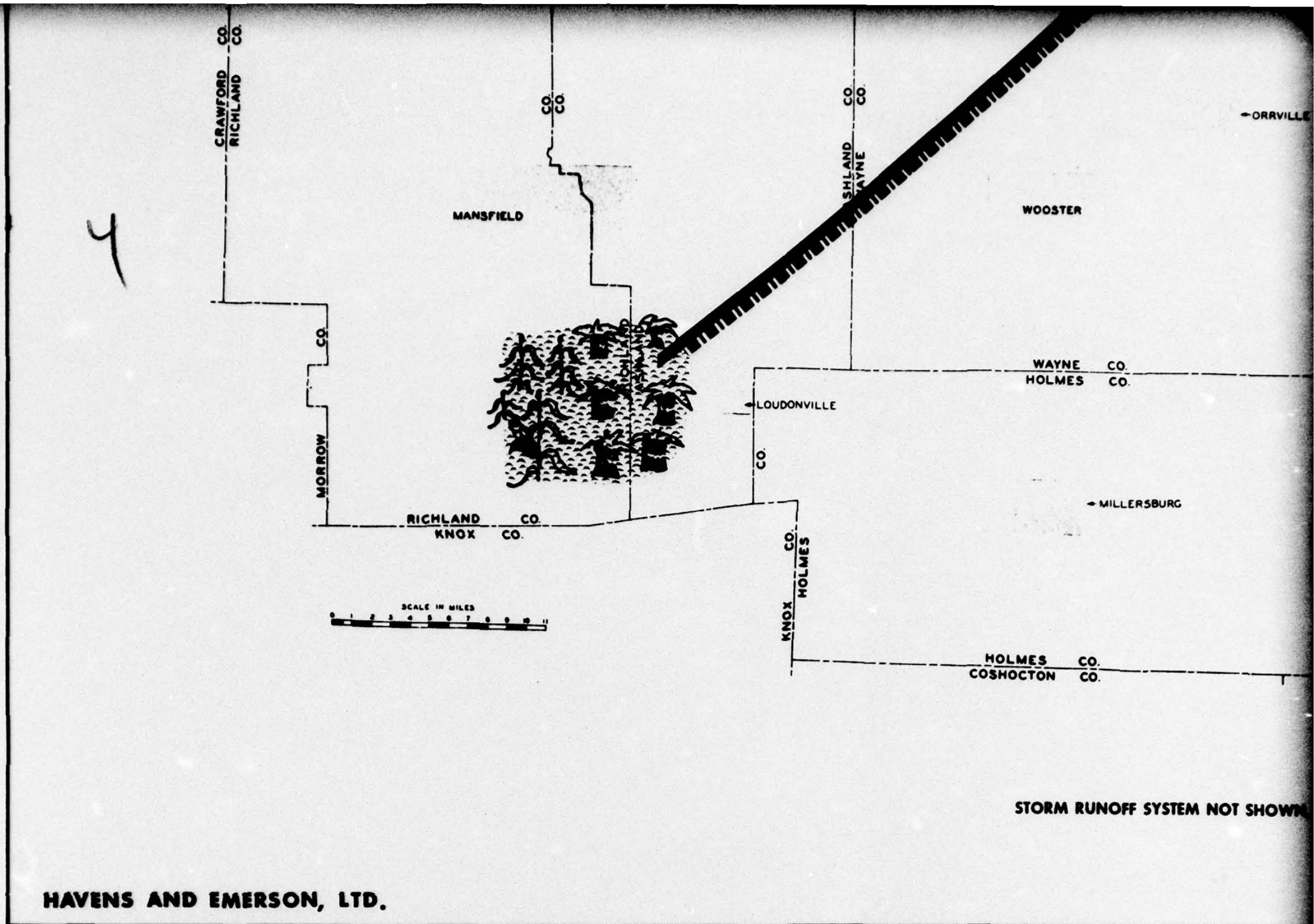

LEGEND
AERATED LAGOON
COLLECTION POINT
RETURN LINES
SPRAY IRRIGATION SITE
SPREADING-PERCOLATION BASIN
STORAGE BASINS
STORM RUNOFF INTERCEPTOR
TRANSMISSION LINES
TREATMENT PLANT
STORM RUNOFF TREATMENT
LORAIN METROPOLITAN AREA
AMHERST
ERIE CO.
HURON CO.
LORAIN CO.
CUYAHOGA CO.
MEDINA CO.
ASHLAND CO.
RICHLAND CO.
CRAWFORD CO.
WAYNE CO.
EAST BRANCH
WEST BRANCH
ROCKY RIVER
MEDINA
MANSFIELD
WOOSTER

2



LAKE ERIE
ASHTABULA
GENEVA
LAKE CO.
ASHTABULA CO.
GEAUGA CO.
LAKE CO.
GEAUGA CO.
ASHTABULA CO.
TRUMBULL CO.
TRUMBULL CO.
PORTAGE CO.
MAHONING CO.
CLEVELAND METROPOLITAN AREA
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
GARRETTSVILLE
CUYAHOGA CO.
MEDINA CO.
SUMMIT CO.
HUDSON
WINDHAM
WARREN METROPOLITAN AREA
MEDINA
RAVENNA
TRUMBULL CO.
MAHONING CO.
AKRON METROPOLITAN AREA
YOUNGSTOWN METROPOLITAN AREA
MEDINA SUMMIT
SUMMIT CO.
PORTAGE CO.
PORTAGE CO.
STARK CO.
RITTMAN
SEBRING
SUMMIT CO.
STARK CO.
SALEM
MAHONING CO.
COLUMBIANA CO.
ORRVILLE
WAYNE CO.
STARK CO.
MASSILLON - CANTON METROPOLITAN AREA
LEETONIA
COLUMBIANA
EAST PALESTINE
LISBON


3
CONNEAUT
ASHTABULA
OHIO
PENNSYLVANIA
ASHTABULA CO.
TRUMBULL CO.
WARREN
ROPOLITAN
AREA
TRUMBULL CO.
CO.
YOUNGSTOWN
METROPOLITAN
AREA
OHIO
PENNSYLVANIA
SALEM
MAHONING CO.
CO.
LEETONIA
COLUMBIANA
EAST
PALESTINE


4
CRAWFORD CO.
RICHLAND CO.
CO.
CO.
SHLAND CO.
WAYNE CO.
ORRVILLE
MANSFIELD
WOOSTER
MORROW CO.
WAYNE CO.
HOLMES CO.
LOUDONVILLE
CO.
MILLERSBURG
RICHLAND CO.
KNOX CO.
KNOX CO.
HOLMES
SCALE IN MILES
HOLMES CO.
COSHOCTON CO.
STORM RUNOFF SYSTEM NOT SHOWN
HAVENS AND EMERSON, LTD.

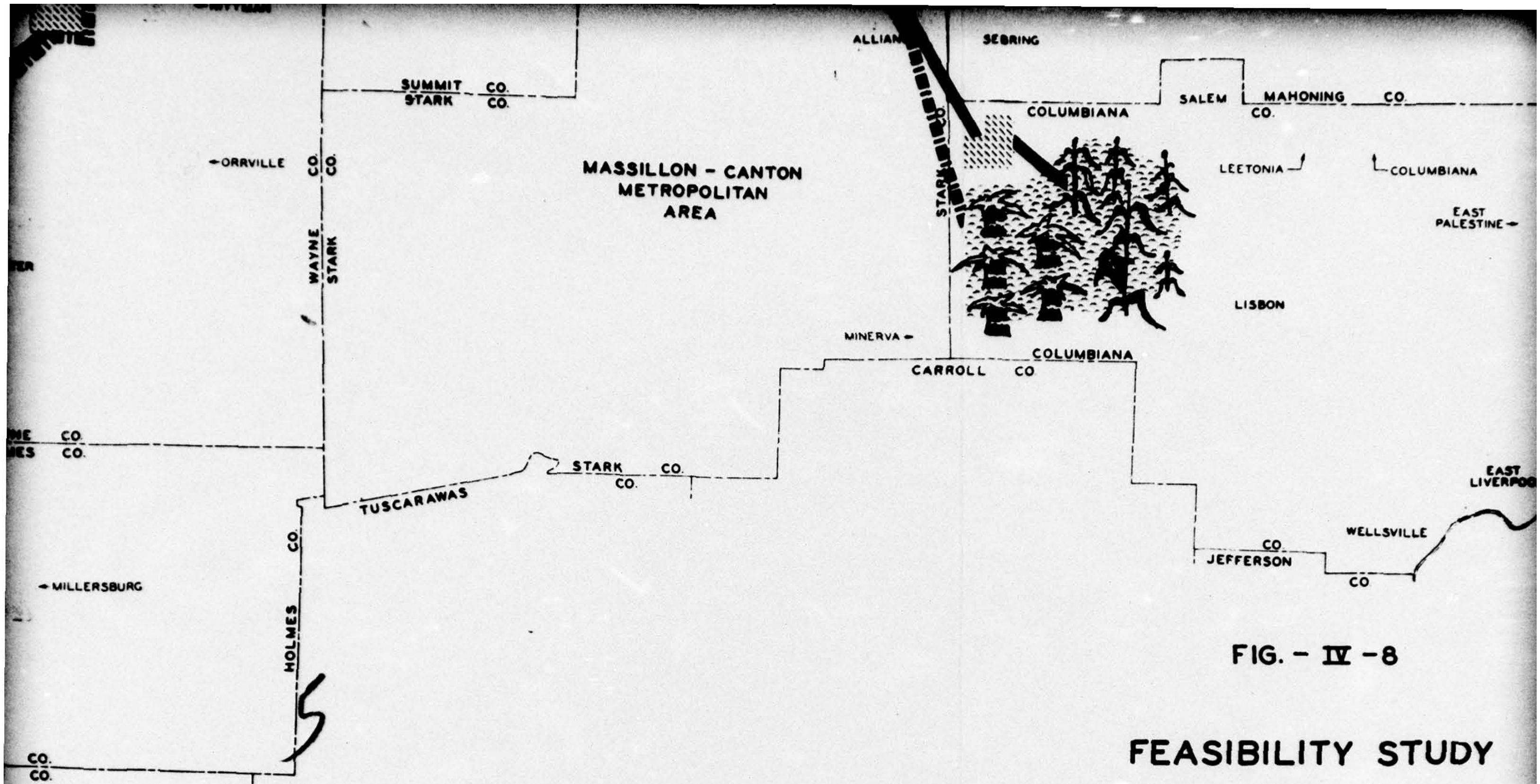


FIG. - IV -8

FEASIBILITY STUDY
FOR
WASTEWATER MANAGEMENT PR

M RUNOFF SYSTEM NOT SHOWN, HOWEVER IT IS THE SAME AS W-1.

C-4

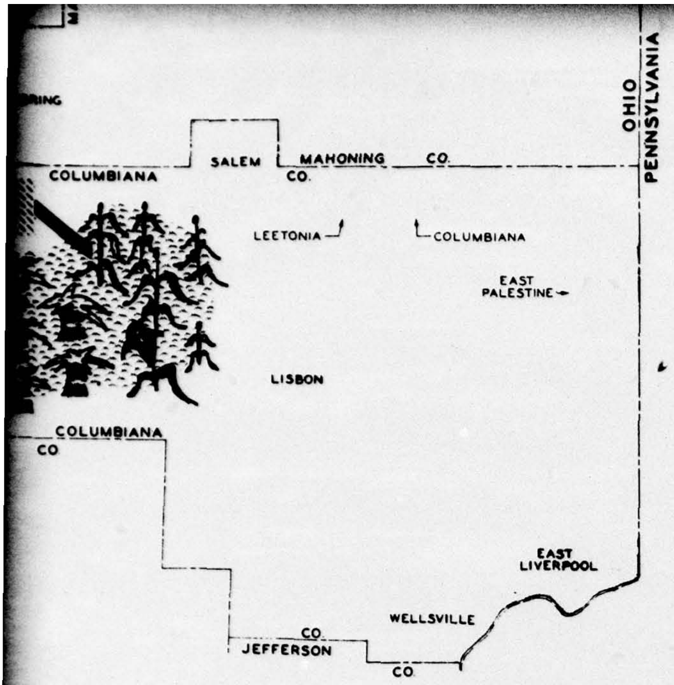


FIG. - IV -8

FEASIBILITY STUDY
FOR
ASTEWATER MANAGEMENT PROGRAM

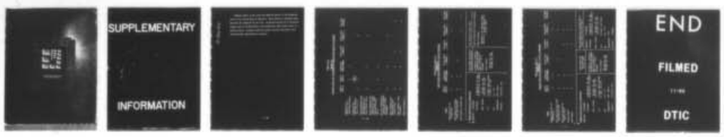
C-4

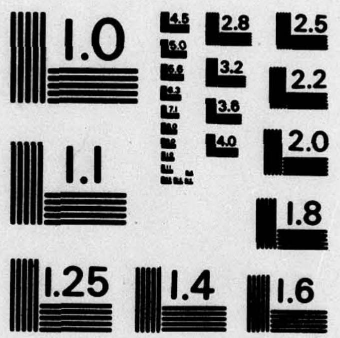
6

ATTACHMENTS

AD-A036 834   ALTERNATIVES FOR MANAGING WASTEWATER FOR CLEVELAND - AKRON METROPOLITAN A..(U) CORPS OF ENGINEERS BUFFALO N Y BUFFALO DISTRICT JUL 71   4 of 4

UNCLASSIFIED   F/G 13/2   NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SUPPLEMENTARY

INFORMATION

Offshore waters in the study area approach quality of the background water in the central basin of Lake Erie. Water quality is generally good, and meets the standards for all uses. Occasional periods of low dissolved oxygen occur in the hypolimnion, and intermittent algae blooms attest to nutrient excess. Seasonal turnovers promote vertical circulation which causes periodic deterioration in quality.

TABLE II-24

SUMMARY OF
CUYAHOGA RIVER OHIO DEPARTMENT OF HEALTH WATER QUALITY STANDARDS

	Aquatic Life A	Aquatic Life B	Industrial Water Supply	Public Water Supply	Partial Body Contact	Full Body Contact
Cuyahoga River from S.R. 17 to Coast Guard Station:		X	X			
Cuyahoga River from Lake Rockwell Down to S.R. 17:	X	(Until 1975) X			X	
Little Cuyahoga River upstream of S.R. 91 and downstream of Hazel Street, Akron:	X		X		X	
Little Cuyahoga River between S.R. 91 and Hazel Street; Summit Lake and the Ohio Canal:		X	X			
All other tributaries between Lake Rockwell and Harvard Avenue, Cleveland:	X		X		X	
Upper Cuyahoga River Basin above Lake Rockwell Dam:	X		X	X		X
Lakes, Hodgson, Muzzy and Sandy	X		X	X		X
Lakes, currently in use for swimming and						

TABLE II-24 (Cont'd.)
SUMMARY OF
ROCKY RIVER OHIO DEPARTMENT OF HEALTH STANDARDS

Reach	Aquatic Life A	Industrial Water Supply	Public Water Supply	Cold Water Fish	Partial Body Contact	Full Body Contact
Rocky River and all tributaries	X	X			X	
East Branch and Baldwin Creek near reservoir	X	X	X			
East Branch at Albion Park	X	X			X	X

Rocky River and all tributaries:	East Branch and Baldwin Creek near reservoir:	East Branch at Albion Park
Requires: 4 freedoms: Coliforms: 5,000/100 ml, mo. avg.; 20,000/100 ml, 5% samples Diss. Solids: 750 mg/1, mo. avg.; 1,000 mg/1, any time D.O.: 5.0 mg/1, daily average; 4.0 mg/1, any time pH: 6.0 - 8.5 Temperature: 90°F. (Max.) Toxicity: 1/10 48 Hr. TLm	In addition, requires threshold odor number: Not to exceed 24 at 60°C. as a daily average. Diss. Solids: 500 mg/1 mo. avg. 750 mg/1 any time.	Same as Rocky River except coliforms. Fecal Coliforms: 200/100 ml. mo. geometric means 40C/100 ml. in more than 10% of monthly sample

TABLE II-24 (Cont'd.)

SUMMARY OF

CHAGRIN RIVER OHIO DEPARTMENT OF HEALTH STANDARDS

Reach	Aquatic Life A	Industrial Water Supply	Public Water Supply	Cold Water Fish	Partial Body Contact	Full Body Contact
Chagrin River and all tributaries	X	X			X	
East Branch and Main Stem near Daniels Park	X	X	X		X	
Main Stem upstream of Chagrin Falls	X	X		X	X	
Aurora Branch	X	X		X	X	
East Branch	X	X		X	X	

Chagrin River and all tributaries:	East Branch and Main Stem near Daniels Park:	Main Stem upstream of Chagrin Falls, Aurora Branch and East Branch:
Requires: 4 freedoms: Coliforms: 5,000/100 ml, mo. avg. 20,000/100 ml, 5% samples Diss. Solids: 750 mg/l, mo. avg. 1,000 mg/l, any time D.O.: 5.0 mg/l, daily average 4.0 mg/l, any time pH: 6.0 - 8.5 Temperature: 90°F. (Max.) Toxicity: 1/10 48 hr. TLm	In addition, required threshold odor number: Not to exceed 24 at 60°C. as a daily average. Diss. Solids: 500 mg/l mo. avg. 750 mg/l any time	Requires: 4 freedoms Coliforms: 5,000/100 ml, mo. avg. 20,000/100 ml, 5% samples Diss. Solids: 750 mg/l, mo. avg. 1,000 mg/l, any time D.O.: 6.0 mg/l, all times pH: 6.5 - 8.5 Temperature: 70°F. Toxicity: $1/10T_{M48}$

END

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